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PhD thesis

Etiology of Crown Rot of Organic Bananas

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SUPERVISOR: Prof. Marco Saracchi

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Corso di dottorato in: Chimica, biochimica ed ecologia degli antiparassitari**.**

PhD thesis: **Etiology of Crown Rot of Organic Bananas**.

By

Mohamed AbdALLA Mohamed KAMEL

XXVIII CYCLE (2013 – 2015)

COMMISSIONE: ESAMI FINALI DI DOTTORATO. 17 Dicembre 2015.

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DEDICATION

This thesis is dedicated to my wonderful father Dr. AbdALLAH Kamel and the dearest mother Fatma Ahmed being to my heart, without whom none of this would have been even possible.

It is dedicated as well to my smole family, my wife Doaa Moustafa the most lovely person in my life simply she is my life story; the sweetest daughter Zynab and son AlQasim in entire universe; you were the wind beneath my wings. All of you offered me unconditional love and support throughout the time. You have been with me every step of the way, through good times and bad.

My big family as well, brothers; Khadiga, Zynab and Ahmed, and their families with all members. Thank you all for all the unconditional love, guidance, and support that you have always given me, helping me to succeed and instilling in me the confidence. I love you, really!!

I would like to dedicated my thesis and express my thanks to Egypt and all people who taught me the value of education and longing to learn more and more; e.g. Dr. Ahmed Sayed, all Students of "discovery leadership program" and members of Institute of International Education (IIE), and many friends. I am deeply indebted to all, for their continued support and unwavering faith in me, especially when I need encouragement. You taught me a great deal about all aspects of life.

Finally, this thesis is dedicated to all those who believe in the science as way of development and anyone who believes in the importance of their role in life.

Mohamed Kamel

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There are also so many people who have helped me throughout my masters and for whom I am grateful. Finally, to everybody, and to all the ones I unforgivably forgot, honest appreciation.

Mohamed Kamel

It's bananas,,,
Magical fruit, that is available all over the year, production is continuous, the price is cheap almost constant throughout the time, desirable and acceptable to the majority, also rich in nutritional value and consumed as source of starch as well as in many countries, various parts of the plant considered for consumption, and used as an essential ingredient in food industries.

(Mohamed Kamel 2015)

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II. List of Figures

III. List of abbreviations

African, Caribbean and Pacific	(ACP)
Base pair	(bp)
Before Common Era	(BCE)
Carnation Leaf Agar	(CLA)
Celsius	(°C)
Cetyl TrimethylAmmonium Bromide –method-	(CTAB)
Colony Forming Units	(CFU)
Common Market Organization	(CMO)
Czapek dox Agar	(CDA)
Czapek Yeast Agar	(CYA)
Department of Food, Environmental and Nutritional Sciences	(DeFENS)
Disease incidence	(DI)
Disease severity	(DSI)
European Union	(EU)
Food and Agriculture Organization	(FAO)
Gram	(g)
Generally Recognized As Safe	(GRAS)
Hydrated potassium aluminium sulfate "potassium alum $KAl(SO_4)_2 \cdot 12H_2O$"	(Alum)
Integrated management practices	(IPM)
Internal transcribed spacer	(ITS)
International Code of Nomenclature	(ICN)
Malt Extract Agar	(MEA)
Martin's Rose Bengal Agar	(MRBA)
Microliter	(µl)
Micrometer	(µm)
Millilitre	(ml)
Millimeter	(mm)
Nanogram	(ng)
Nutrient Agar	(NA)
Oat Meal Agar	(OMA)
Polymerase chain reaction	(PCR)
Potato Dextrose Agar	(PDA)
potential hydrogen	(pH)
Richard's V8	(RV8)
Richards Agar	(RA)

Species pluralis	(spp.)
Species singular	(sp.)
Tag Image File Format	(TIFF)
The glyceraldehyde-3-phosphate dehydrogenase gene	(GPDE)
The intergenic region of apn2 and MAT1-2-1 genes	(ApMat)
The media B	(MB)
The translation elongation factor 1-α	(TEF)
United States of America	(USA)
Unweighted pair-group method with arithmetic	(UPGMA)
Volume	(V)
Waksman's Glucose Agar	(WGA)
Water Agar	(WA)
Windward Islands	(WI)
β-tubulin	(BT)

IV. Abstract

Crown rot is one of the most important postharvest diseases with a great negative impact on banana fruit quality. Bananas are harvested green and many packaging processes are carried out before coming on the market. The infections occur at harvest, but the symptoms appear after overseas transportation. Different pathogens are involved in crown rot, varying according to farming area. Little is known about its etiology and causal agents in organic farming. Dominican Republic is one of the leading exporters of organic bananas, and therefore, in this PhD thesis, five organic farms and their corresponding packing stations located in Valverde were investigated. To the best of our knowledge this is the first study covering Dominican Republic and it focused in particular on: the disease etiology, conditions, infection time and mechanisms that determine its development. Over a period of three years, 558 banana hands were collected and a total of 5000 fungal colonies were obtained from the crown tissues and 1750 representative colonies were purified. The identification of mycoflora associated with crown tissues was carried out with the final aim to search for disease management strategies compatible with organic production. Fungi were found in all the analyzed samples collected from various processing stages: from field to packing houses, and obtained in high rate starting from field from flowers as well as crown parts. The diffusion of the pathogen inoculum occurs principally during the banana processing, especially during the dehanding and in washing tanks. The final crown trimming followed by washing and quality of water used in the application of protective products were the critical points of crown infections. Five hundred and eighteen representative colonies were characterized and identified using morphological and molecular methods. The fungal community was dominated by *Fusarium*, the most frequent genus (55%) found in more than 80% of all analyzed samples. It was represented by nine species; *F. incarnatum* 53%, *F. verticillioides* 12%, *F. sacchari* 12%, *F. proliferatum* 7%, and *F. solani* 6%. Strains belonging to eight less frequent genera were represented by *Colletotrichum musae* 7% and found in 13% of all samples; *Lasiodiplodia theobromae* 4% and *L. pseudotheobromae* 1%, both found in 7% of all samples; *Nigrospora* sp. 11%, *Alternaria* spp. 6%, *Phoma* spp. 2%, *Pestalotiopsis* sp. 2%, *Curvularia* spp. 1% and *Microdochium* sp. 1%. Considering the main genera, the results based on morphological and molecular aspects showed a high variability among strains. By conducting the experimental inoculation trials, *C. musae* strains resulted from the most virulent among different species, followed by *F. sacchari*, *L. theobromae*, *L. pseudotheobromae* and *F. verticillioides*. The remaining strains had low pathogenicity, and their role could be ancillary in the crown rot development, or could be considered saprophytic. Summarizing the isolation frequency and pathogenicity tests, *F. incarnatum* strains played the main role in crown rot disease of organic bananas in the investigated areas.

Keywords: Cavendish AAA, Packaging process, Crown trimming, *Colletotrichum musae*, *Fusarium* spp., *Lasiodiplodia theobromae,* and Postharvest disease.

V. Educational and scientific activities during the PhD

Activity Title	Description	Data	CFU
Theoretical Courses	"Past and future in crop protection chemicals"	29th January 2013	3
	"Resistance to fungicides: monitoring and management"	3 - 7 February 2014	3
	"Mycotoxigenic fungi and mycotoxin contamination management"	17 - 21 February 2014	3
Intensive Courses	Microscopy School	April 16th to 18th 2013	3,5
	Academic writing in the scientific field	13 -16 May 2013	3
	Professional presentations for scientific communication	20 -23 May 2013	
	Writing to communicate science: a practical workshop	19 - 20 November 2014	3
	Plant Cell Walls	26 - 29 January 2015	3
	Publishing connect Author ' Elsevier workshop'	13th April 2015	1
	Italian language course (30 hours)	6Feb. to 31 May 2013	0
	Formazione Generale dei Lavoratori	4 - 6 November 2013	0
Practical Courses	"Characterization of toxigenic fungi"	26 May - 16 June 2014	2
	"Analysis of microbial communities in complex matrices: PCR-DGGE of 16S rRNA gene sequences".	27 - 28 May 2014	2
	"PCR-fingerprinting for microbial strain typing"	7 July 2014	2
Seminar Courses	"Study of Microorganisms Based on Color"	14th February 2013	0,5
	"Beyond the biocide: examination of the use of nitric oxide-based treatments in the control of biodecay of cultural materials"	15th November 2013	0,5
	"Cultures on Culture: A Social Scientific Perspective on Cultural Heritage Restoration Technologies"	11 June 2014	0,5
	"Mycotoxin contamination on harvested commodities and innovative strategies for their detection and control"	20 July 2015	0,5
Annual PhD International Workshop	VIII Workshop of the PhD Course of "Chemistry, Biochemistry and Ecology of Pesticides"	21 January 2013	5
		27 – 28 January 2014	5
		18 – 19 December 2014	5
Abroad period	One mission to Egypt.	24/04 - 05/05/2013	5
	Different missions to Dominican republic.	07- 23/06/2013 06 - 13/10/2013 02 - 10/03/2014 21/9 - 02/10/2014	
National or International Meetings	"The cost of fiction vs. science in agriculture: The rejection of transgenic crops in Italy and Europe".	12 Giugno 2014	1
	The "Eleventh Arab Congress of Plant Protection" held in Amman- Jordan. (Oral presentation).	9 - 13 November 2014	5
	Poster in the "III International Symposium on Postharvest Pathology: Using Science to Increase Food Availability". Bari (Italy).	7-11 June 2015	5

	Poster in the "XVIII. International Plant Protection Congress (IPPC)" Berlin, (Germany).	24 - 28 August 2015	5
	The "XXI Convegno Nazionale Società Italiana Patologia Vegetale" Torino, (Italy) (Oral presentation).	21- 23 September 2015	3
Oral presentation to National or International Meetings	Oral presentation in The "Eleventh Arab Congress of Plant Protection" held in Amman- Jordan.	10 November 2014	4
	Oral presentation in The "XXI Convegno Nazionale Società Italiana Patologia Vegetale" Torino, (Italy)	21 September 2015	4
		The total CFU	77,5

Teaching Activities	I was participating in educational activities like doing lessons with Prof. Sardi, and also the laboratory activity with prof. Saracchi.	The academic year 2014/2015
Supervising Master and Bachelor students. As (Correlatore)	Thesis of Giuseppe SOLURI (Laurea Magistrale)	Academic year 2012/2013
	Thesis of Laura Aurora STRAZZULLO (Laurea)	Academic year 2012/2013
	Thesis of Federica DRAGO (Laurea)	Academic year 2013/2014
	Thesis of Danae Estefania CANADAS SALAZAR (Laurea)	Academic year 2013/2014
	Thesis of Elisabetta BONZINI (Laurea)	Academic year 2014/2015
	Thesis of Sara TREU (Laurea)	Academic year 2014/2015
	Thesis of Ludovica GIGLIO (Laurea)	Academic year 2014/2015
Awards	Best Oral presentation in The "Eleventh Arab Congress of Plant Protection" Amman- Jordan.	10 November 2014
	Best poster in the "III International Symposium on Postharvest Pathology". Bari (Italy).	7-11 June 2015
	Free (one-year subscription to the Italian Phytopathological Society and consequently to the Journal of Plant Pathology).	June 2015
Under Publications	"Source and spread of fungal pathogens causing crown rot disease in organic bananas"	Submitted to "Acta Horticulturae"
	"Etiological agents of crown rot disease affecting organic bananas in Dominican Republic"	Submitted to "Tropical Plant Pathology Journal"
	"pathogenicity of etiological agents of crown rot disease on organic banana in Dominican Republic"	Will be submit to "Journal of Plant Pathology"
	Under publication "Morphological and molecular characterization of *Fusarium* spp. isolated from Crown rot of organic bananas"	In preparation
	Under publication "Morphological and molecular characterization of *C. musae* and *L. theobromae* involved in Crown rot disease of organic bananas"	In preparation

1 Chapter One : Introduction.

Banana is one of the most important world crops, which is available all over the year. Its production is continuous in more than 130 countries across the area of tropics and subtropics, where it is considered the staple food and economic life line predominantly (Arias, 2003; Lassois *et al.*, 2010b; Mohapatra *et al.*, 2010). It is the world's first cultivated fruit, it started to be farmed 7000 years ago, with a vital source of food calories for humans over the ages (Yen, 1973; Moberg, 2003). Certain translations of the Old Testament suggest the forbidden fruit in the Garden of Eden was actually a banana, not an apple. It has a long history of importance to humans "banana history tells the human history" (Robinson and Saúco, 2010). The "Ancient humans" used bananas and the banana plants as an important source of food, construction materials, and cultural symbols. The plant was introduced to the New World by Spanish or Portuguese from Africa in 1516 (Denham, 2004; Denham *et al.*, 2004; Denham, 2005; Ayto, 2012). In the nineteenth century it continued to be a cultural and caloric necessity for humans and now it is one of the four most important staple crops and the world's most exported fresh fruit in terms of volume and value (Frison and Sharrock, 1998; Arias, 2003). The economies of some countries are dependent on the export of bananas which is characterized by stable price that is almost constant through the time. Most bananas are planted for sale in local markets or self-consumption, and only a fraction of all bananas produced are sold in the world market (Arias, 2003; FAOSTAT, 2015). India is the world leader in banana production, producing around 18% of the worldwide crop (FAOSTAT, 2013). Nowadays, the market consists mainly of the trade of Cavendish type bananas and approximately 26 % is exported. The three main exporter countries in Latin America are Ecuador, Costa Rica and Colombia, whereas in Asia the Philippines, in Africa Cameroon and Côte d'Ivoire and in the Caribbean the Dominican Republic and the Windward Islands (Arias, 2003). The Dominican Republic has become the largest exporter among the Caribbean countries, especially of organic tropical fruits (Raynolds, 2008; FAOSTAT, 2015). The cultivation of organic bananas began there in 1982, and over 60.000 tonnes of organic bananas were exported in 2002, while in 2012 were exported more than 302.000 tons, dominated by organic production (Arias, 2003; Raynolds, 2008; FAOSTAT, 2015). The main markets for organic bananas are Germany, the Netherlands and the United Kingdom (Arias, 2003; FAOSTAT, 2015).

According to some etymological dictionaries, there are two hypotheses about the origin of word banana. It might have come from the Arabic word "banan", which means "finger" or perhaps borrowed by Spanish or Portuguese from a West African word, possibly Wolof banana (Koeppel, 2007; Ayto, 2012).

1.1 The origin and distribution of bananas

According to the archaeologists, the origin of bananas was in Kuk valley in New Guinea around 8.000 BCE, where humans domesticated banana (Denham, 2004). Robinson and Saúco in 2010 summarized the history of banana distribution and trade in their book "Bananas and plantains" in the following points:

- 500s- Introduction to Africa from Indonesia (via Madagascar).
- 1000s- Distribution throughout Polynesia and introduction to Mediterranean areas during Muslim expansion.
- 1300s-1400s- Introduction to the Canary Islands from West Africa.
- 1516- First recorded introduction to the New World (Santo Domingo) from the Canary Islands.
- 1500s-1800s- Distribution of bananas and plantains throughout tropical America.
- Early 1800s- Introduction to the New World of cultivars “Dwarf Cavendish” and “Gros Michel” from South-east Asia.
- Late 1800s- Beginning of international trade.
- 1900s- Banana becomes a major food item in the temperate-zone markets of the Western world as well as the Far East.
- 1993- Establishment of the Common Market Organization (CMO) for banana in the European Union (EU), based on a quota system and other compensatory aids for European producers and African, Caribbean and Pacific (ACP) countries.

Nowadays, bananas are distributed as staple crop in the tropical zone where the economies of some countries are depending on it. In addition, it is the developing world's fourth most important food crop after rice, wheat and maize in terms of gross value of production (Frison *et al.*, 2004).

1.2 Banana taxonomy

The genus *Musa* (order: Zingiberales, family: Musaceae), contains more than 40 mainly seedless (parthenocarpic) species and the number of chromosome sets (ploidy) were used to group different *Musa* species (Simmonds, 1959; Simmonds, 1987; Simmonds and Weatherup, 1990). For example, there are diploids: AA, AB and BB, triploid hybrids e.g.: AAA, AAB and ABB, which include famous cultivars; as well as different tetraploids –the rarer ones- e.g.: AAAA, AAAB, AABB and ABBB. *Musa* species grow in a wide range of environments and have various human uses ranging from the edible bananas and plantains of the tropics to cold-hardy fiber and ornamental plants (Robinson and Saúco, 2010). As shown in the scheme (figure 1-1), the cultivated bananas derive from two wild species native to Southeast Asia: *Musa acuminata* “AA” and *M. balbisiana* “BB” (Simmonds and Shepherd, 1955). *M. balbisiana* is a hardier and more drought tolerant plant than *M. acuminata*, and also more disease resistant. By hybridization it was possible to control the plant characters keeping the quality features as well as to cultivate bananas in different geographical range (Jarret, 1987; Silayoi and Chomchalow, 1987).

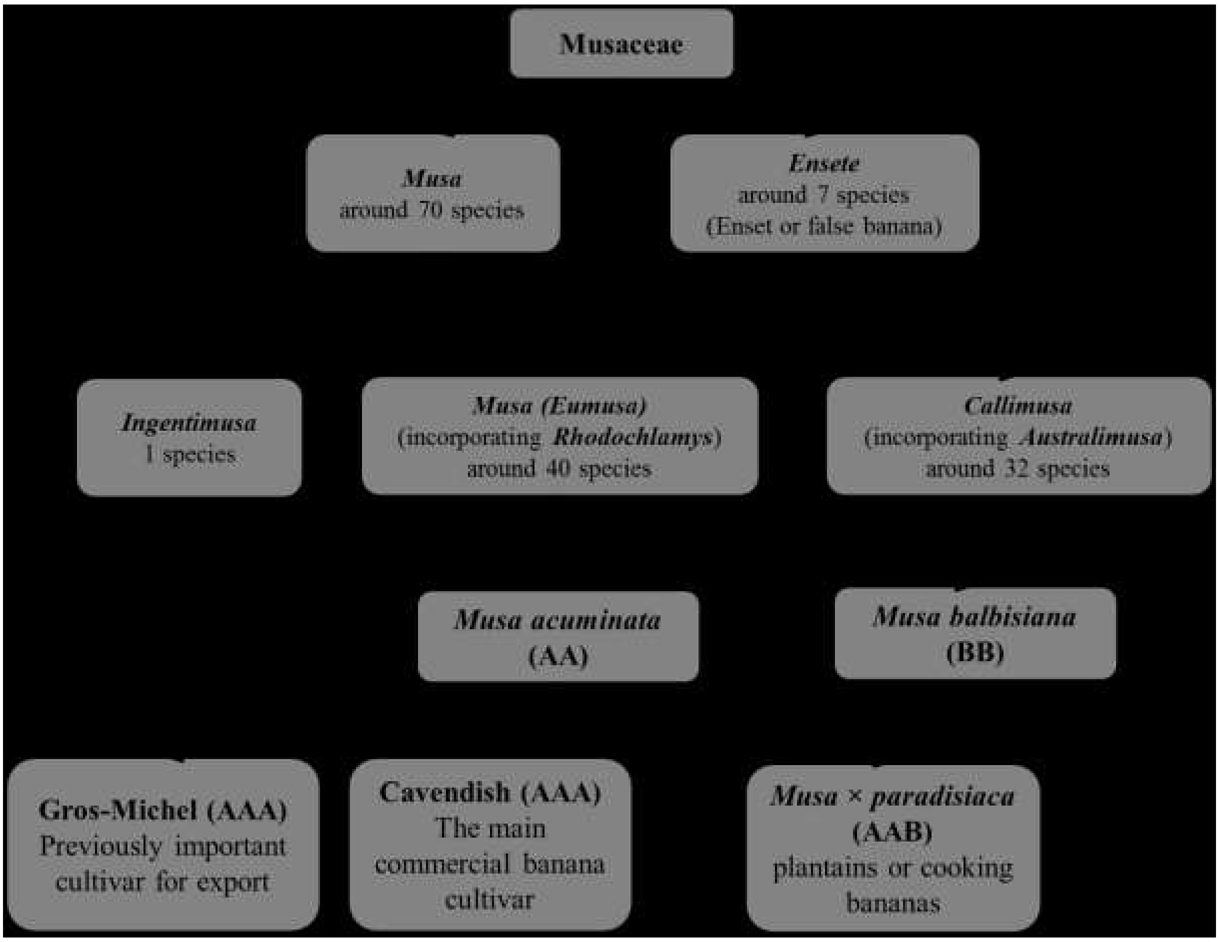


Figure 1-1. The classification of bananas.

1.2.1 Cavendish bananas

It is the main commercial banana cultivar all over the world. This important cultivar belongs to the triploid AAA group of *Musa acuminata*. Until 1960, only Gros-Michel subgroup cultivars were harvested for export, but these cultivars were susceptible to Panama disease caused by different races of *Fusarium oxysporum* f. sp. *cubense*, and thus were replaced by Cavendish subgroup cultivars because of their resistance to Panama disease (Lassois *et al.*, 2010b). But recently, *F. oxysporum* f. sp. *cubense* race four attacks diverse banana genomes including the AAA genotypes Cavendish and Gros Michel (De Ascensao and Dubery, 2000).

1.2.2 Plantains

The plantain (*Musa × paradisiaca*) is interspecific hybrid form the subgroup “AAB”, produced as a natural crossing between *Musa acuminata* that provided genome A and *Musa balbisiana* that provided genome B (Simmonds and Shepherd, 1955; Simmonds, 1966). Plantain is the starchier fruit similar to banana but normally it is consumed cooked as a source of starch. Instead, the sweeter fruits present on the market and normally consumed uncooked, are called banana. They are harvested green and obtain the yellow color as they become more mature.

1.3 Banana plant

Banana plant is considered to be the largest herbaceous flowering plant (Heslop-Harrison and Schwarzacher, 2007). It is not a tree because the trunk is actually a false stem or pseudostem that is not woody and composed of tightly packed leaf sheaths (IPGRI-INIBAP/CIRAD, 1996). The aerial parts die and fall on the ground at the end of the growing season. It is a perennial plant, as the offshoots or suckers growing at the base of the plant normally replace the mother plant. The term "mat" (figure 1-2) is used to designate the plant unit “mother plant, its suckers and the underground rhizome” (IPGRI-INIBAP/CIRAD, 1996). Banana fruits -fingers- are arranged and connected by crown forming hands, which are attached together to form the bunch (Karamura and Karamura, 1995). The bunch is the descriptive term for all the fruits along the rachis, which is the stalk of the inflorescence from the first fruit to the male bud (figure 1-2). According to Guinness World Records, the largest bunch, containing 473 individual bananas, was grown in Canary Islands, Spain and weighed 130 kg on 11th July 2001.

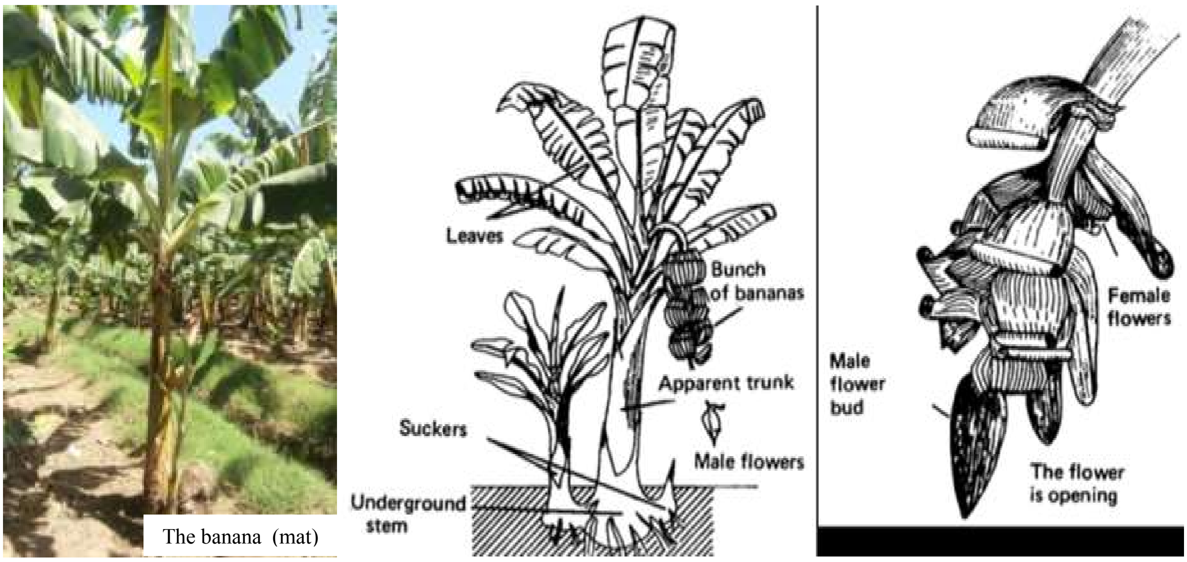


Figure 1-2. The banana plant unit: mother plant, suckers, the underground rhizome and the bunch.

(the source: www.fao.org).

1.3.1 Rhizome

The rhizome (figure 1-3) is the underground stem of banana, or accurately the corm, that gives rise to numerous pseudostems (Price, 1995). The primary root system originates from the surface of the rhizome's central cylinder (figure 1-4), and it gives rise to secondary roots (IPGRI-INIBAP/CIRAD, 1996).

Figure 1-3. The banana rhizome or underground corm.

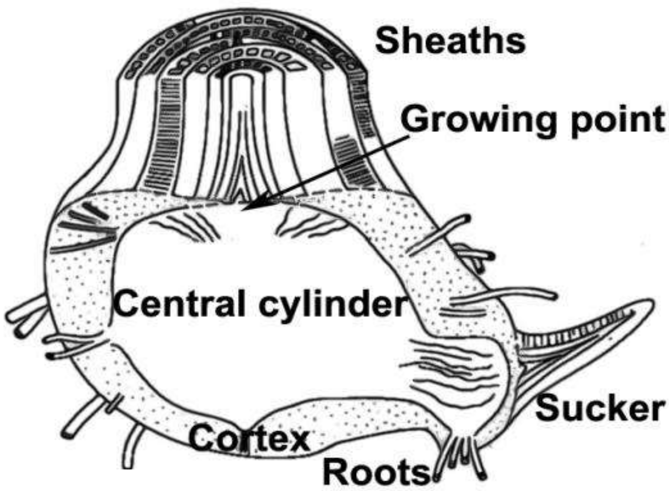


Figure 1-4. Drawing show the different parts of banana rhizome.

(source: www.promusa.org)

1.3.2 Pseudostem

The pseudostem looks like a trunk, but they are tightly packed leaf sheaths (figure 1-5), and even though it is very fleshy and consists mostly of water, it is quite sturdy and can support a bunch that weighs 50 kg or more (Karamura and Karamura, 1995; IPGRI-INIBAP/CIRAD, 1996). It reaches its maximum height when the floral stem, which supports the inflorescence, emerges at the top of the plant.

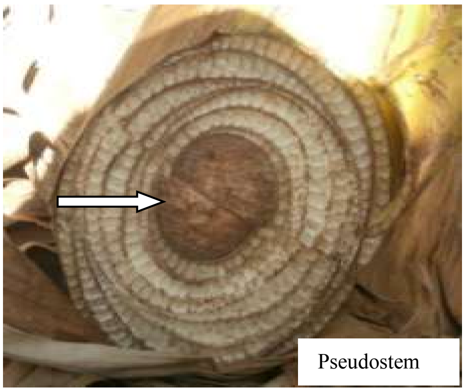


Figure 1-5. The banana pseudostem and the floral stem, visible in the center.

1.3.3 Suckers

The suckers normally develop from the rhizome close to the mother plant as lateral shoots (figure 1-6). They are responsible also about the reproduction, where the strongest sucker is selected to replace the mother plant after fruiting, is called “follower”. Morphologically, there are two types of suckers; one called “sword” that is characterized by narrow leaves and a large rhizome, and the other one -water sucker- that has broad leaves and a small rhizome. The number of suckers produced varies with the type of cultivar.

Figure 1-6. The banana suckers.

1.3.4 Leaf

Photosynthesis in plants is mainly done by leaves. The “scale leaves” are the primary leaves produced by a growing sucker, while “foliage leaves” are the mature leaves that consist of sheath, petiole, midrib and blade (figure 1-7). Each leaf emerges from the center of the pseudostem as a rolled cylinder. The “cigar leaf” is a recently emerged leaf still rolled as a cylinder (figure 1-8). Commonly it takes about seven days to unfold under favorable climatic conditions.

Figure 1-7. The banana leaves. The foliage leaves (A),the detail of the foliage leaf (B) and the cross section (C) that shows the base of banana leaves around the center of the pseudostem.

Figure 1-8. The cigar leaf.

1.3.5 Inflorescence

The inflorescence is a complex structure that is supported by the floral stem -true stem- (figure 1-2). The floral stem is produced by the terminal growing point through the pseudostem on the rhizome and called “peduncle”. It emerges at the top of the plant soon after the last cigar leaf, and then starts pointing down (figure 1-9). In cultivated bananas, the female “pistillate” flowers appear first (figure 1-9), and the ovary develops into a seedless fruit by parthenocarpy without being pollinated. The bract -a modified leaf- as it lifts or curls up, exposes a cluster of female flowers that are normally arranged in two rows. Later on, these flowers will develop to be a hand containing a number of fruits. The number of hands in the bunch depends on the number of female clusters in the inflorescence, and varies depending on the genotype and environmental conditions (figure 1-10). After the female flowers develop, the distal portion of the inflorescence elongates and produces clusters of male “staminate“ flowers, each subtended by a bract. The male flowers in the male bud produce pollen that may or may not be sterile. Other type of flowers called “hermaphrodite” that may be present on the stalk between the female flowers and the male bud, without known function and their stamens do not produce pollen.

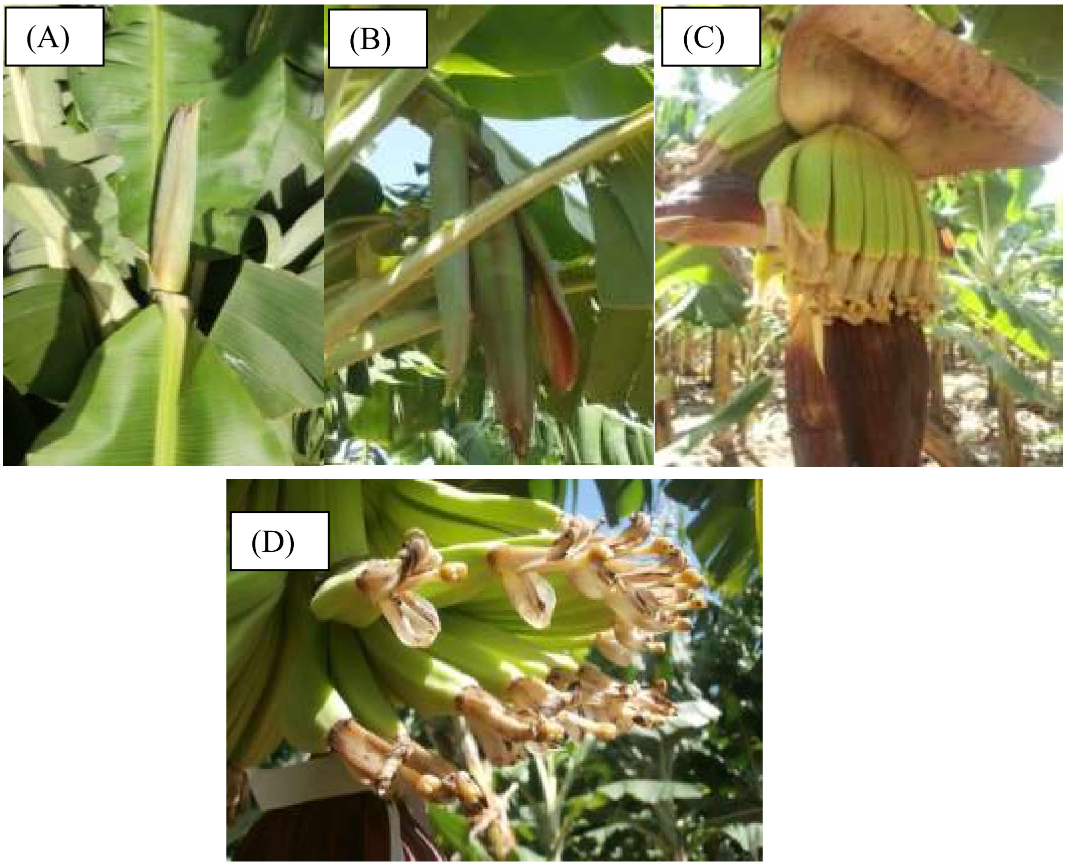


Figure 1-9. The development of the floral stem. The emerging inflorescence (A), Inflorescence pointing down (B), "Bract" and flowers arranged (C) and finally the inflorescence is emerges and female flowers developed attached to banana fingers (D).

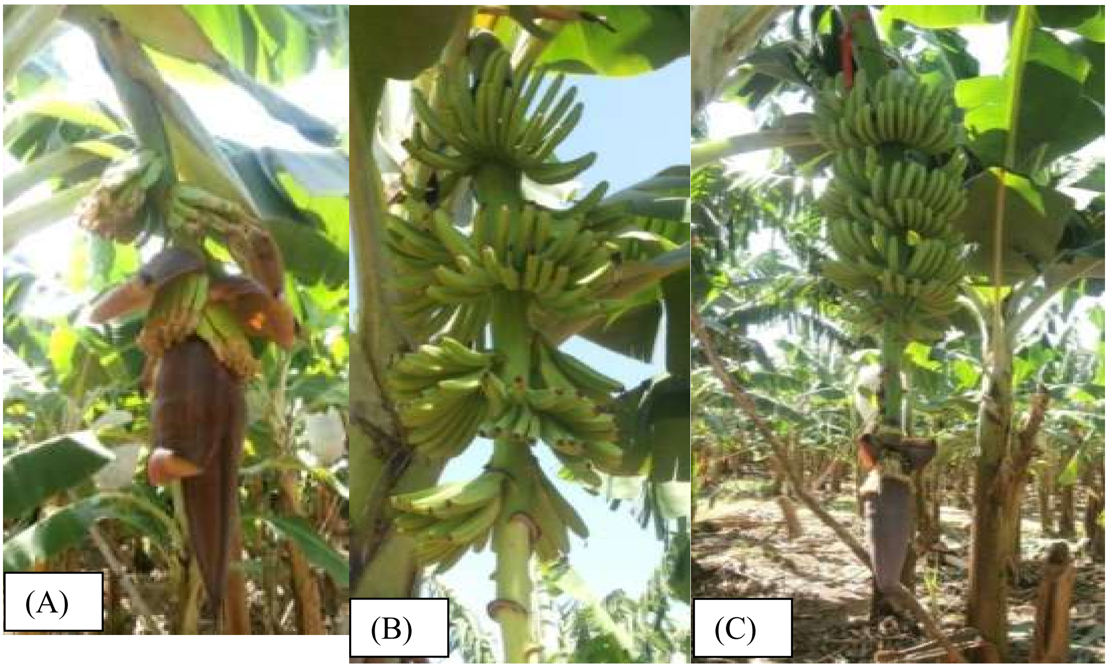


Figure 1-10. Stages of the formation of banana bunch: Forming of banana bunch(A), Cluster of female flowers develop into a hand of fruits (B) and entire banana bunch (C).

1.4 Propagation methods

The principal method of banana propagation is the division of suckers or pups, which arise from the base of the stem or underground corm. Apart from this, the tissue culture technique is the most rapid method of propagation of valuable disease-free material, using the micropropagation technique in order to produce healthy banana plantlets from selected commercial varieties (figure 1-11).

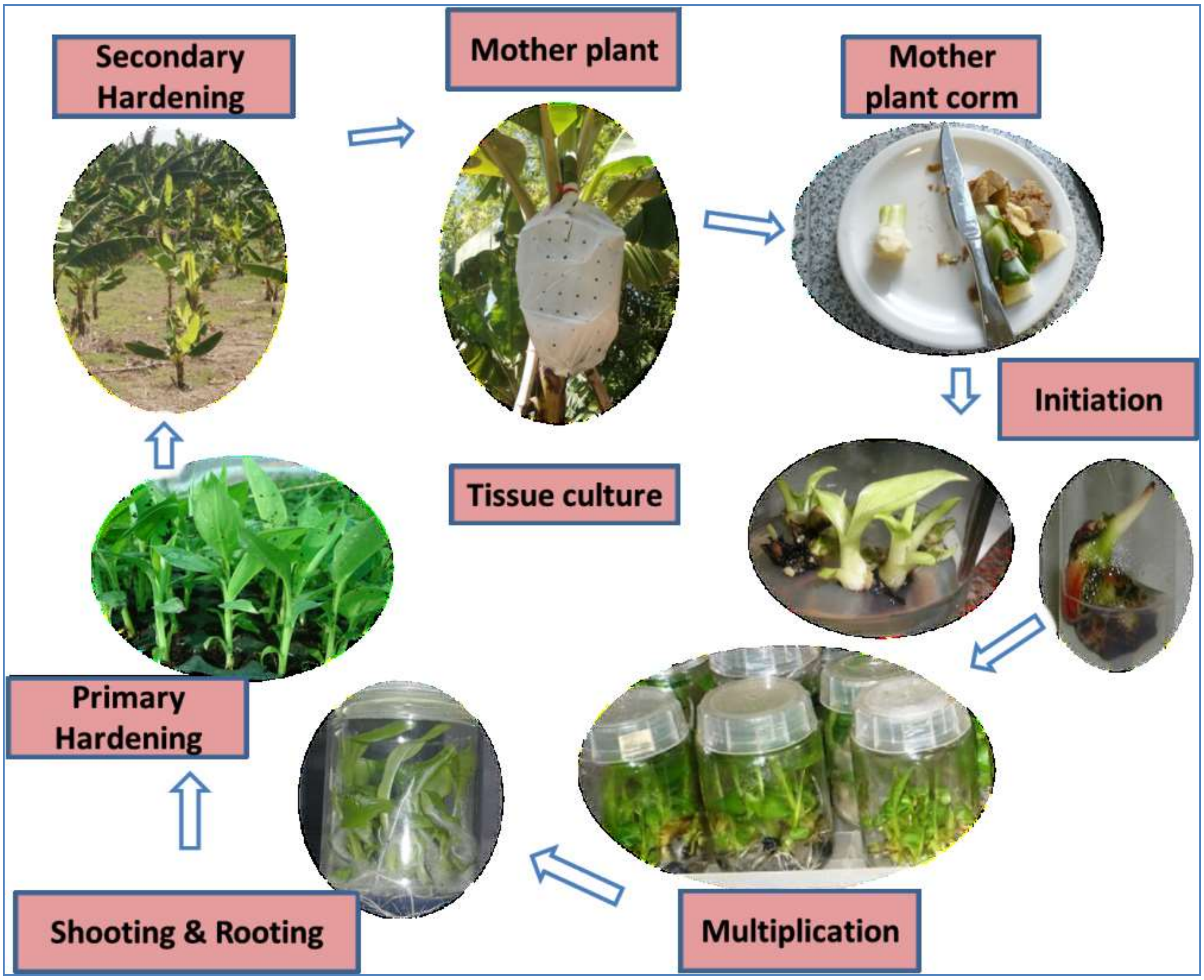


Figure 1-11. The cycle of propagation banana using tissue culture (micropropagation) technique.

1.5 Banana production

Banana is a tropical crop cultivated in more than 100 countries, mainly in tropics and subtropics area (Lassois *et al.*, 2010a) (figure 1-12), with a total production of 106 million tons in 2013 (FAOSTAT, 2015) (figures 1-13, 1-14).

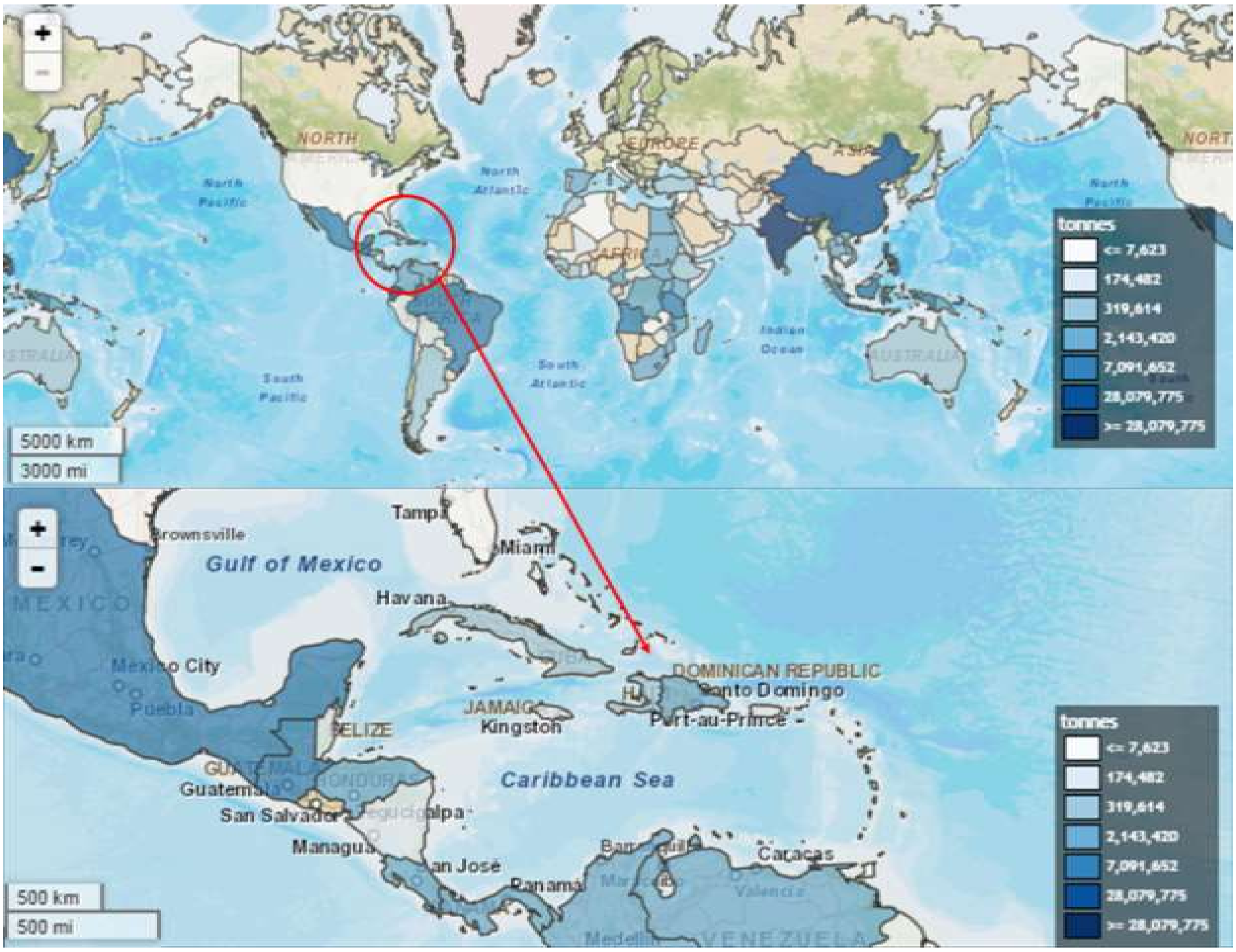


Figure 1-12. The map showing different countries producing banana especially the Caribbean in 2013.

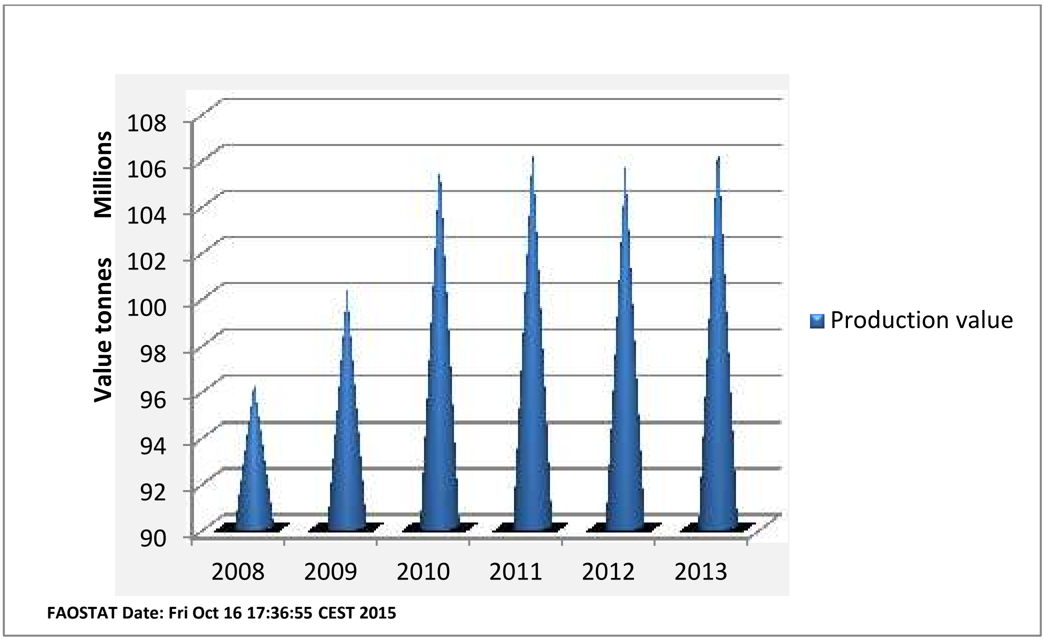


Figure 1-13. The total world production of banana recently, 2008-2013.

(source: www.faostat.fao.org)

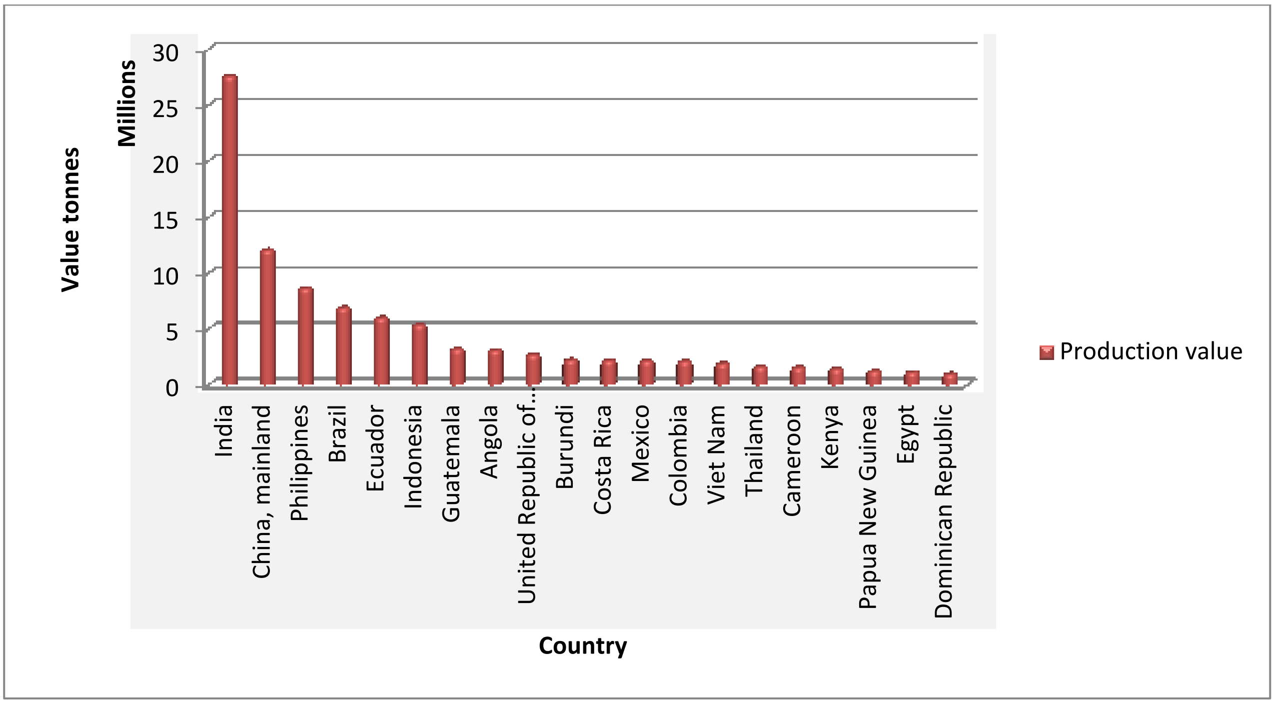


Figure 1-14. Top twenty banana production countries in 2013.

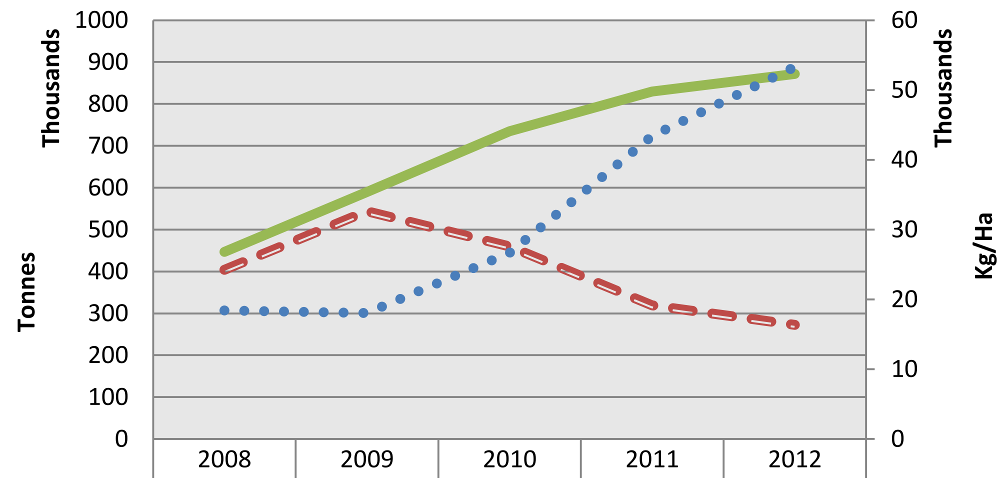
(source: www.faostat.fao.org)

The production of bananas in Dominican Republic was the second most important after sugar cane in 2012 (table 1-1), and reached approximately 871 thousand tonnes (figure 1-15).

Table 1-1. Production quantity of top commodities in Dominican Republic 2012.

vegetative products		Quantity tonnes
1	Sugar cane	4865576
2	Bananas	871898
3	Rice, paddy	849695
4	Papayas	815499
5	Plantains	543461
6	Pineapples	447432
7	Avocados	290011
8	Tomatoes	258811

Source: FAOSTAT, FAO of the UN, Accessed on February 4, 2015.
http://faostat.fao.org/site/567/default.aspx#ancor



	2008	2009	2010	2011	2012
Production (tonnes)	446531	589589	735045	829827	871898
Yield (Kg/Ha)	24256	32641	27571	19126	16358
Area harvested (Ha)	18409	18063	26660	43388	53300

FAOSTAT Date: Fri Oct 16 17:36:55 CEST 2015

Figure 1-15. Area harvested, yield and production of bananas in Dominican Republic from 2008 to 2012.

(source: www.faostat.fao.org)

Dominican Republic is considered the biggest exporter of organic banana to Europe (FAOSTAT, 2015) (figures 1-16, 1-17), where cultivation is concentrated in Mao, Valverde area (figure 1-18).

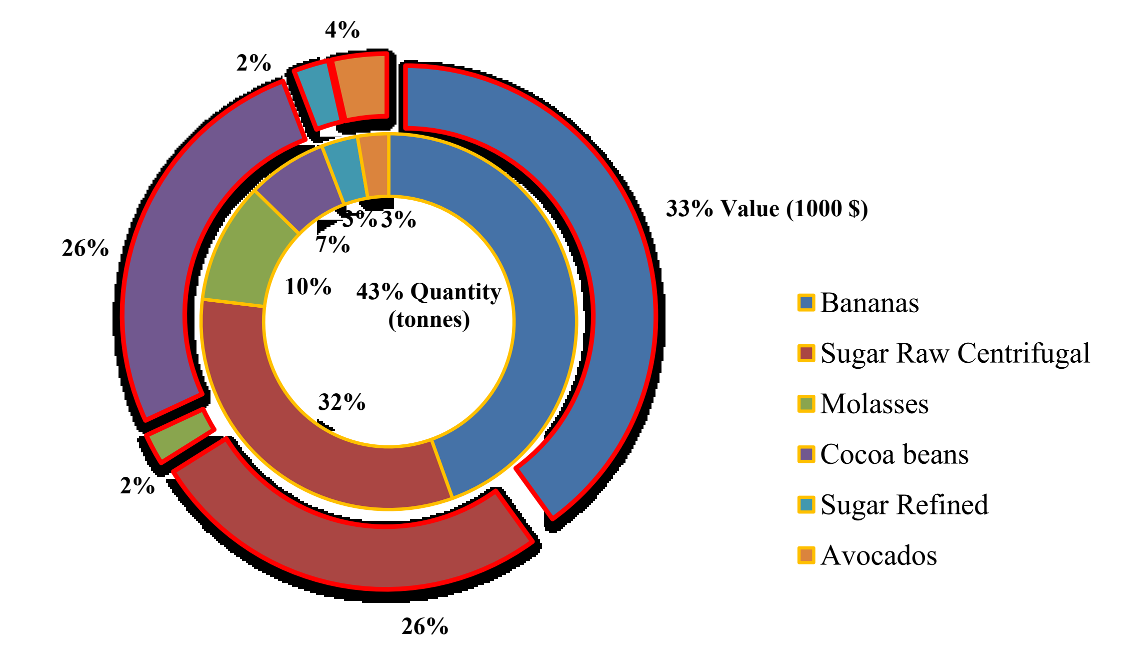
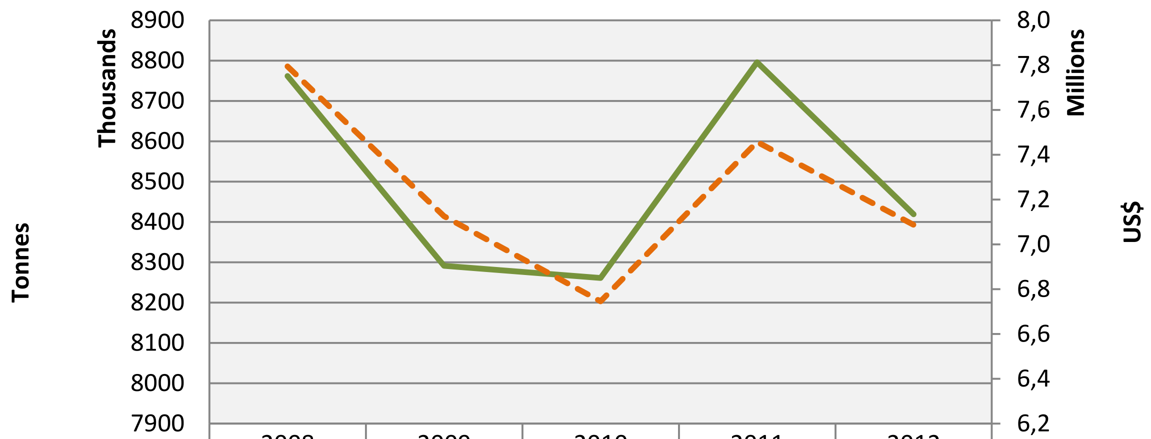


Figure 1-16. Top agricultural products exported from Dominican Republic in 2013, dominated by banana.

(source: www.faostat.fao.org)



	2008	2009	2010	2011	2012
Import Quantity	8761204	8291117	8261182	8795843	8419096
Import Value	7793612	7125488	6745023	7456579	7087073

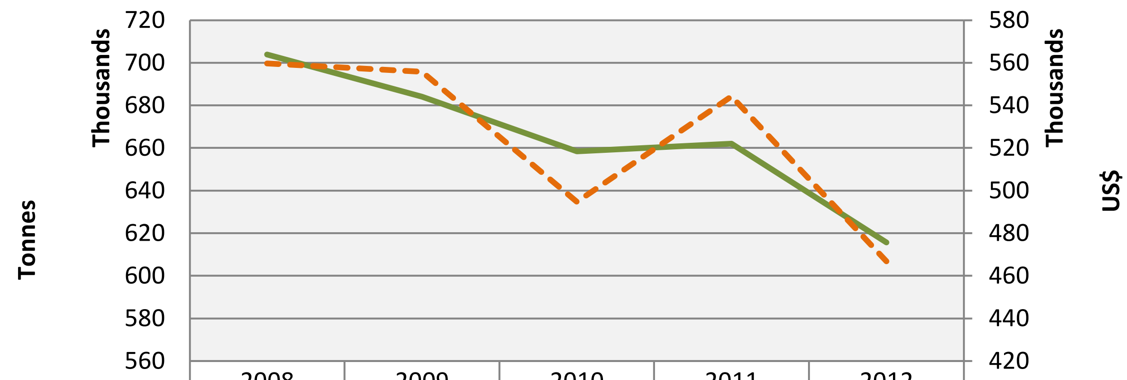
FAOSTAT Date: Wed Oct 21 10:15:54 CEST 2015

Figure 1-17. Quantity and value of bananas imported to Europe from 2008 to 2012.

(source: www.faostat.fao.org)

Figure 1-18. Map of Dominican Republic, indicating the Mao, Valverde area, where the production of organic banana is concentrated.

In 2011, Italy imported about 661000 tonnes of conventional and organic banana fruits (FAOSTAT 2014) (figure 1-19).



	2008	2009	2010	2011	2012
Import Quantity	703897	684104	658391	661937	615608
Import Value	559699	555747	494719	544168	466738

FAOSTAT Date: Wed Oct 21 10:15:54 CEST 2015

Figure 1-19. Quantity and value of bananas imported to Italy from 2008 to 2012.

(source: www.faostat.fao.org)

In different countries, especially the big producers like India, they did not differentiate between the production data of banana and plantain, and consequently these data are not available in reports of Food and Agriculture Organization (FAO).

1.6 Bananas postharvest processes

Bananas are harvested while still green, and then they are passed through different stages from field until packaging. Following, the banana postharvest processing is described; which arrive to the packinghouse as bunches. First step is cleaning bunches using water with soap under pressure pumping. After that start the dehanding process, where each hand is divided and the quality and the maturity are controlled. Then the hands enter the delatexing bath in order to release the latex that comes out naturally when cutting banana tissues. After 15 – 20 minutes, the hands are divided into small clusters with appropriate number of fingers (clustering) as well as the shape of crown area is regulated (trimming). Then the bananas enter the second washing tank for 20 minutes to remove and wash the remaining latex. After that, they are subjected to the treatment with compatible disinfectant products and packaging (figure 1-20). In organic banana production, they normally used hydrated potassium aluminium sulfate "potassium alum $KAl(SO_4)_2 \cdot 12H_2O$" (Alum). For exportation, bananas are shipped to the port and then to Europe, while maintaining the temperature of transportation and storage at 13°C. After the arrival of the bananas to the destination, they enter in a closed rooms chamber with controlled type and amount of gas. They are exposed to doses of the ethylene gas to unify the color and help the maturation, and then they are distributed to consumers.

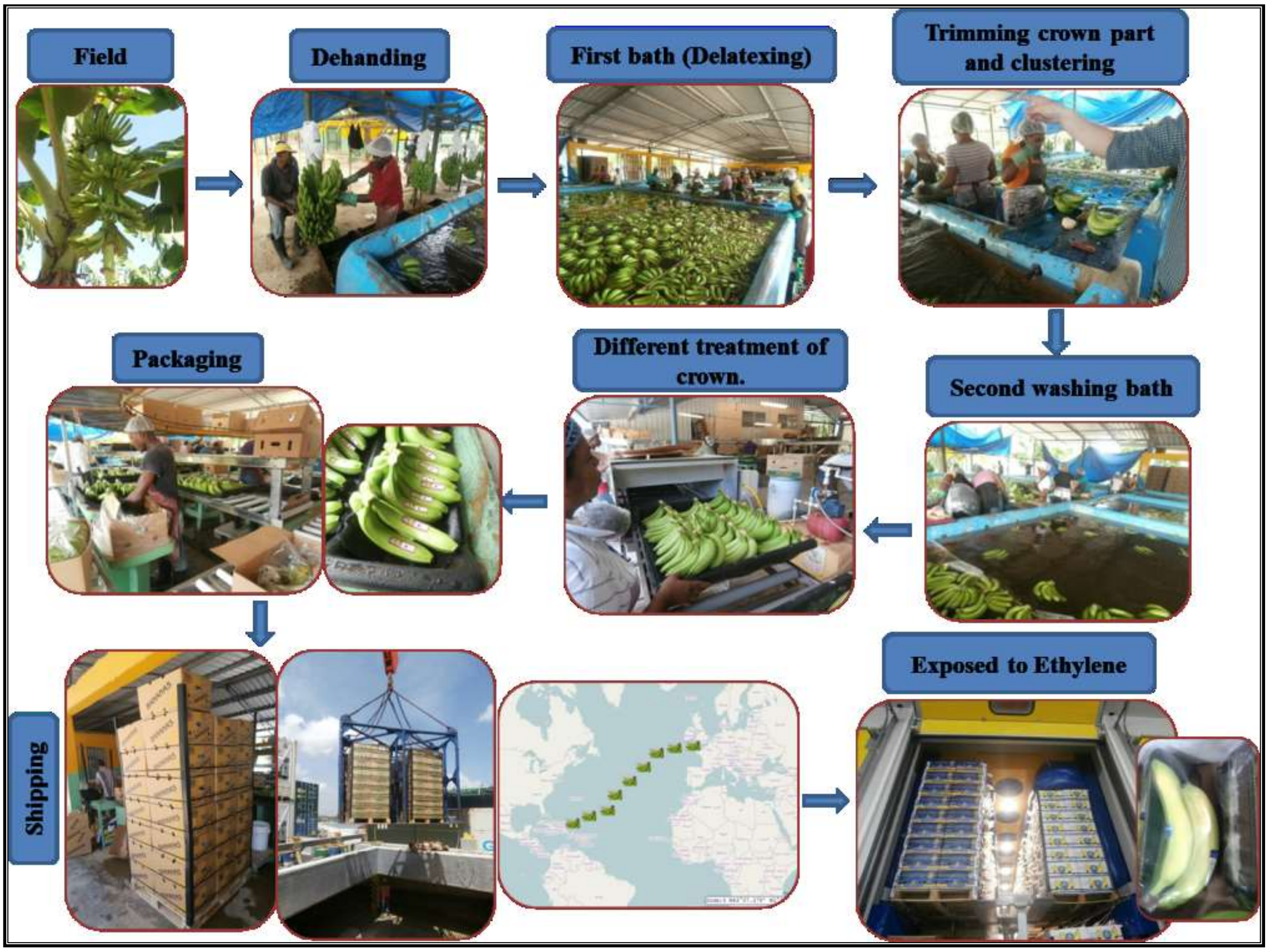


Figure 1-20. Diagram of the different stages of banana postharvest processing.

1.7 Organic bananas

Contemporary ideas of organic production were introduced into the Dominican Republic in the early 1980s, but it was not until the mid-1990s that the production expanded (FAO, 2003). In 1999, organic production was estimated to contribute about 20% of total agricultural exports with a value of US$ 9.6 million. In 2000, the value of organic exports had doubled to US$ 20.9 million (FAO, 2003). The Dominican Republic exports almost all of its organic banana production to Europe, and especially Germany, with their exports reaching 300.000 tons in 2012 (BananaLink, 2012; FAOSTAT, 2015). Dominican Republic is one of the leading exporters of tropical organic products dominated by bananas, which represent about 80% of all organic exports (Holderness *et al.*, 2000; FAO, 2003). Organic certified fresh bananas grown in Dominican Republic are destined for export to the European Union, North America and Japan (BananaLink, 2012). In addition, small volumes of Biodynamic bananas are grown on two plantations (one in Dominican Republic and one in Egypt). The market for organic produce continues to grow and the scope for expansion of production is therefore great (Holderness *et al.*, 2000; Sauvé, 2000; FAO, 2003). Ethylene gas is permitted for use in the ripening of bananas within organic standards (BananaLink, 2012).

1.8 Banana diseases

Bananas are affected by several important diseases, whether pre- or post- harvest and significant losses of bananas may occur (Ploetz, 1997; Ploetz, 2003) (table 1-2). Some of them are very aggressive or spread easily and others are really difficult to eradicate, in which many factors interact, like the environmental conditions, the variety of bananas, and the etiological agents. Banana hybrids and breeding to develop resistant varieties are highly recommended to combat different diseases, such as *Fusarium* wilt (Panama disease). On the other hand, the use of synthetic fungicides is quick and easy solution in different cases, but it was restricted and regulated in organic farming. Crown rot is considered one of the most important postharvest diseases, causing a great negative impact on fruit quality (Umana-Rojas and Garcia, 2011a).

Table 1-2. Names and etiological agents of some of the important diseases affecting banana plant.

	Disease name	Etiological agents
Fungal diseases	Anthracnose	*Colletotrichum musae*
	Armillaria corm rot	*Armillaria mellea* and *A. tabescens*
	Black leaf streak/Black Sigatoka leaf spot	*Mycosphaerella fijiensis*
	Sigatoka leaf spot/Yellow Sigatoka leaf spot	*Mycosphaerella musicola*
	Cigar-end rot	*Verticillium theobromae* and *Trachysphaera fructigena*
	Crown rot	Different fungi such as*; Fusarium spp.; Colletotrichum musae; Lasiodiplodia theobromae*; *Nigrospora* spp.; *Verticillium theobromae;* and others.
	Fusarium wilt “Panama diseases”	*Fusarium oxysporum* f. sp. *cubense*
	Lasiodiplodia finger rot	*Lasiodiplodia theobromae*
	Peduncle rot	*Colletotrichum musae*; *Lasiodiplodia theobromae*; *Fusarium* spp.; *Verticillium theobromae*
Bacterial diseases	Xanthomonas wilt	*Xanthomonas campestris* pv. *musacearum*
Virus diseases	Bract mosaic	*Banana bract mosaic virus*
	Bunchy top	*Banana bunchy top virus*
	Streak	*Banana streak virus*

1.9 Crown rot

Bananas are harvested while still green and many packaging processes are carried out before coming on the market. Crown rot is a complex disease, which is considered the main postharvest fungal disease of bananas, and it is found wherever bananas are grown (Alvindia, 2013). Different etiological agents are responsible for crown rot disease, and their composition varies according to farming area, geographical zone, weather, banana cultivars and plant health. From different cultivated area, fungi were reported such as *Fusarium* spp. (Link), *Colletotrichum musae* (Berk. & Curt.) Arx., *Lasiodiplodia theobromae* (Pat.) Griff. & Maubl., *L. pseudotheobromae* (A.J.L. Phillips, A. Alves & Crous), *Nigrospora sphaerica* (Sacc.), *Cladosporium* spp., *Acremonium* spp., *Penicillium* spp., *Aspergillus* spp. and various *Fusarium* spp. including: *F. musae* (Van Hove, Waalwijk, Munaut, Logrieco & Ant. Moretti) and *F. incarnatum* (Desm.) (Goos and Tschirsch, 1962; Meredith, 1962; Greene and Goos, 1963; Mulvena *et al.*, 1969; Griffee, 1976; Knight, 1982; Eckert and Ogawa, 1985; Reyes *et al.*, 1998; Krauss and Johanson, 2000; Joas and Malisart, 2001; Khan *et al.*, 2001; Anthony *et al.*, 2004; Alvindia and Natsuaki, 2007; Lassois *et al.*, 2008; Thompson, 2010). Some of these fungi are involved in more than one disease in bananas, such as *C. musae,* which can cause both crown rot and anthracnose; in addition, these pathogens can exist in banana fields as saprophytes on dead banana leaves or inflorescence tissues (Nelson, 2008). The infection mainly occurs at harvest time and during postharvest processing. The fungi can be dispersed by wind and some insects in field, or to end up in the water used to wash banana fruits and to remove latex from the cut surfaces of the banana fruit crowns. Flowers are the main inoculum source for *Fusarium* and for *Colletotrichum*. Furthermore, fungal inoculum present on banana stalks can be knife transferred onto the cut crown surface at dehanding (Finlay *et al.*, 1992) or when clusters are cleaned in contaminated water (Shillingford, 1977). This disease has seasonal variation determined by many pre-harvest factors, one of which is the weather variation (Ewane *et al.*, 2013). It seems that the disease has prevalence in summer period with higher rates of occurrence and in high-rainfall areas. The infections start at harvest and continue during postharvest processing (deBellaire and Mourichon, 1997). The disease is closely linked to poor cultural and disease management practices in the banana field, as well as attributed to non-compliance with supposed sanitary measures during preparations and application to improper postharvest handling (Nelson, 2008). The symptoms usually appear after overseas transportation (deBellaire and Mourichon, 1997), and in case of Dominican Republic the symptoms appear after approximately twelve days from harvest time (figure 1-21). They appear as blackening on crown area and frequently, a layer of whitish mold later develops on the cut crown surface (figure 1-22). In case of advanced infection it can progress internally until it reaches the banana fruits and it can extend into the banana fruit pulp causing a dry, black rot (figure 1-23). In the case of severe infection, the banana fingers may detach from hands (figure 1-23) and the disease may increase rapidly during fruit ripening. Infected fruits are safe for humans to consume; however, the infection reduce fruit quality, shelf life, and marketability, with a significant loss in terms of quality and quantity. In order to control this disease, it is important to apply an integrated management practices (IPM) program, in which the use of synthetic fungicides was regulated and restricted as in organic farming.

Figure 1-21. Crown rot symptoms on bananas after overseas transportation.

Figure 1-22. Different types and level of crown rot symptoms on banana hands.

Figure 1-23. Progress of crown rot symptoms in the internal tissues and the detachment of banana fingers in case of severe crown rot infections.

1.10 **Aims of the work**

Crown rot is a postharvest disease with a great negative impact on banana fruits quality. Little is known about its etiology and causal agents in organic farming. Different fungal pathogens are involved in crown rot, varying according to farming area. Dominican Republic is one of the leading exporters of organic bananas. To our knowledge this is the first study covering Dominican Republic and there are no data available for crown rot etiological agents in organic farming of bananas in this area.

Our research focused on:

- Studying the disease etiology; conditions, infection time and mechanisms that determine the post-harvest disease development.
- Studying the etiological agents, isolation and identification of mycoflora associated with organic bananas at different stages of postharvest processing.
- Searching for ways of disease management strategies compatible with organic production.

1.11 **Research phases**

A- Isolation and identification of the microbial community involved in crown rot.

B- Searching for critical points of banana infections during cultivation in field, at harvest and packaging process.

C- Pathogenicity tests of the isolates obtained in point A, to determine etiological agents causing crown rot.

D- Assessing the genetic variability of the pathogen populations causing crown rot, focusing on *Fusarium* spp., *Colletotrichum musae*, and *Lasiodiplodia theobromae*.

E- Technical suggestions about how to manage crown rot in organic farming and at packaging station.

F- Studying the factors that can influence the epidemics of the disease.

G- Assessing the quality of water used during post-harvest processing.

2 Chapter Two : Etiological agents of crown rot disease infecting organic bananas in Dominican Republic.

2.1 **Introduction**

Bananas are affected by several diseases, and crown rot is considered one of the most important postharvest diseases, causing a great negative impact on fruit quality (Umana-Rojas and Garcia, 2011a). Fungi are the causal agents of crown rot, and genera and species vary according to farming area (Goos and Tschirsch, 1962; Meredith, 1962; Greene and Goos, 1963; Mulvena *et al.*, 1969; Griffee, 1976; Knight, 1982; Eckert and Ogawa, 1985; Reyes *et al.*, 1998; Krauss and Johanson, 2000; Joas and Malisart, 2001; Khan *et al.*, 2001; Anthony *et al.*, 2004; Alvindia and Natsuaki, 2007; Lassois *et al.*, 2008; Thompson, 2010). The disease has seasonal variation determined by many pre-harvest factors, one of which is the weather change (Ewane *et al.*, 2013). Studies on fungal populations related to crown rot on organic bananas are scarce compared to studies on banana from traditional farming. In Costa Rica the most frequent taxa found in diseased samples were *C. musae* and *F. subglutinans* (Umana-Rojas and Garcia, 2011a). In Ghana, *Botryodiplodia theobromae* Pat. (the former name of *L. theobromae*) was the most frequent causal agent (Ocran *et al.*, 2011) as well as in Sri Lanka, causing a fast spread of crown rot (Gunasinghe and Karunaratne, 2009). In this chapter we focused on identifying the etiological agents associated with crown rot disease affecting organic bananas in Dominican Republic, through the isolation and identification of microflora associated with banana at various processing stages, from field to packing house.

2.2 Materials and methods

2.2.1 The variety used

'Cavendish' is a subgroup of the triploid banana cultivars (AAA) of *Musa acuminata* (Arvanitoyannis et al., 2008). This cultivar is distinguished by height and features of their fruits (Elevitch, 2006; Jain and Priyadarshan, 2009). 'Grande Naine' - no longer available because of the susceptibility to "panama disease" - was also known as Chiquita banana, and was the most important clone in the international trade. In this study we used the 'Dwarf Cavendish' cultivar, which is the most widely grown clone (Elevitch, 2006) and it is cultivated also in Dominican Republic according to the organic approaches.

2.2.2 The site

Five different plantations, covering approximately 750 hectares, and their corresponding packing stations located in Valverde province in Dominican Republic were investigated (table 2-1; figure 2-1, 2-2).

Table 2-1. Cultivation area of different sites used in this work.

NO.	Farm name	Cultivation area (Ha)	Geographical coordinates
1	BILLY	131.64	19.615303,-71.090473
2	BOGAERT	48.43	19.634726,-71.267431
3	FERNÁNDEZ	157.73	19.657855,-71.304821
4	MOTA	299.32	19.657057,-71.319509
5	YAQUE	103.14	19.64283,-71.352167

Figure 2-1. The location of five different plantations.

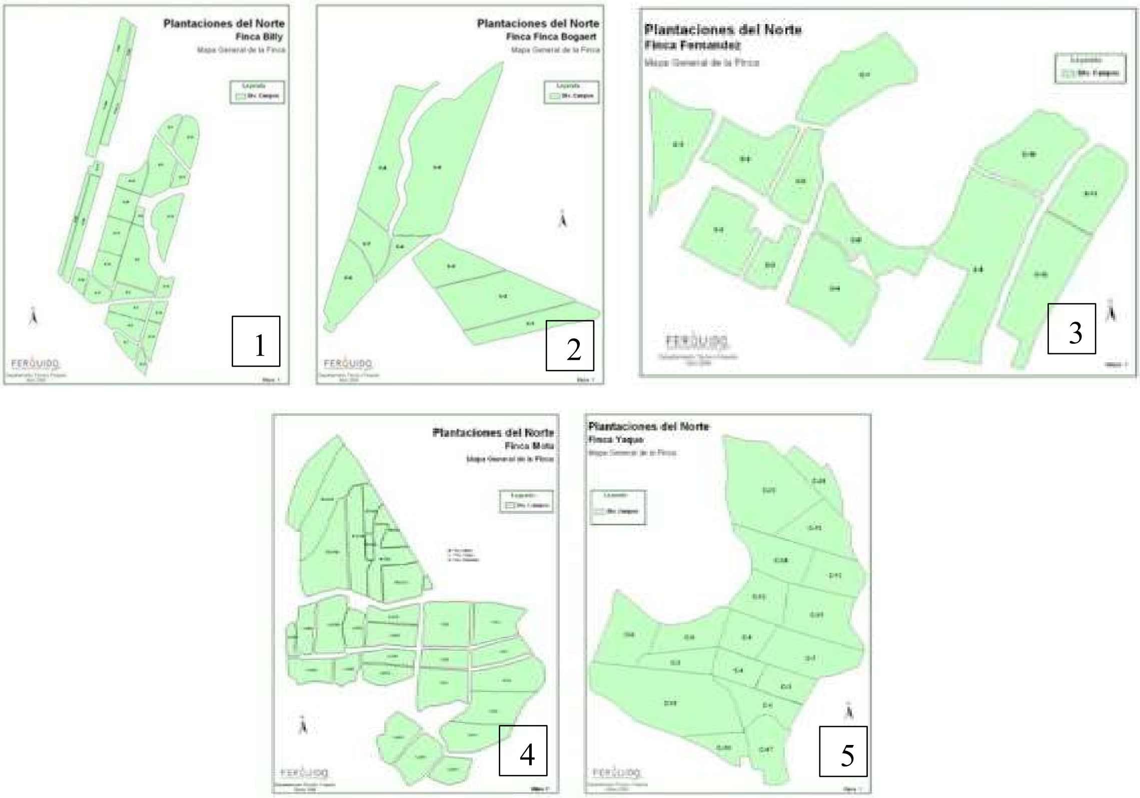


Figure 2-2. An illustrative map showing each of the five different plantations separately.

2.2.3 Sampling

Symptomatic banana fruits were delivered to the laboratory of Plant Patholody, Department of Food, Environmental and Nutritional Sciences (DeFENS), University of Milan, Italy, between February and March 2013. Additional samples were collected on site directly from fields and packing stations as symptomless crowns during different periods over three years (June and October 2013; March, June and September 2014; and March and July 2015). The sampling was done in order to represent all the different stages of cultivation and post-harvest processing of bananas from field until shipping. Flower- and crown parts were sampled in field during deflowering as well as at harvest time. Hands of bananas were collected randomly. The samples were obtained from each step of processing at the packinghouse following the whole process; dehanding, delatexing tank, clustering and trimming, second washing tank, post- treatment and from packaged fruits. Additional sampling included cut crown debris. Each hand was considered a separate sample and 3 replicates were done for each processing-step. The samples were coded and enclosed in marked paper bags before being transferred to the laboratory for further analysis. In some cases, samples were prepared on site, or transferred to our laboratory in Italy. The sample four-alphanumeric code consisted of: the first letter indicated the farm of origin, like B = Billy; the second letter referred to the production stage, like A = dehanding phase; the third letter referred to the day of the week when the sample was taken, like (M = Monday); and the last element is the number of replicate.

2.2.4 Culture media

Thirteen different substrate media were used during the work in different steps (table 2-2), and we mentioned all in this chapter for the purpose of facilitating.

Table 2-2. Different substrate media used in this work and their references.

Full name	Abbreviation	References
Potato Dextrose Agar	PDA	(Difco Laboratories, USA)
Malt Extract Agar	MEA	(Difco Laboratories, USA)
Nutrient Agar	NA	(Difco Laboratories, USA)
Czapek Yeast Agar	CYA	(Difco Laboratories, USA)
Carnation Leaf Agar	CLA	(Fisher *et al.*, 1982)
Oat Meal Agar	OMA	(Bergan and Norris, 1979)
Water Agar	WA	Our laboratory
Richards Agar	RA	(Fahmy, 1923)
Czapek dox Agar	CDA	(Wastie, 1961)
Martin's Rose Bengal Agar	MRBA	(Ranjitham Thangamani *et al.*, 2011)
Waksman's Glucose Agar	WGA	(Ranjitham Thangamani *et al.*, 2011)
Richard’s V8	RV8	(Smart *et al.*, 1992)
Media B (used in chapter 6)	MB	(Ayers *et al.*, 1919; Lynch *et al.*, 1981)

- Potato Dextrose Agar

39 g of ready to use powder (Difco Laboratories, USA) in one liter of deionized water or following the preparation using fresh potato:

20 g	Dextrose – Glucose
18 g	Agar
200g potato	Potato infusion
1000 mL	Deionized water

About 200 g of potatoes, peeled and cut into pieces large enough to prevent the breakup, were left to simmer for 45 minutes in 600-800 ml of deionized water. After that, the liquid phase was recovered by filtration through the gauze and the volume brought up to 1000 ml with deionized water, and then all the other ingredients were added. The media reaction was corrected to pH 6.5 ± 0.5 by adding HCl or NaOH, and autoclaved at 120°C, 1 atm, 20 min.

In all substrate media used we could add different antibiotics in order to be semi-selective. Therefore three antibiotics; Nalidixic acid, Novobiocin and Streptomycin sulfate were used to prevent the bacterial growth. In case the antibiotics were added to the media, they were designed by adding ($^{+++}$) after the media abbreviation. For example, in (PDA^{+++}) we added the antibiotics as sterile solutions to a final concentration of 25 mg/l after the medium was autoclaved at 120°C, 1 atm, 20 min and then cooled to 50°C.

- Malt Extract Agar

30 g	Malt Extract (Difco Laboratories, USA)
15 g	Agar (Applichem, Germany)
1000 mL	Deionized water

- Water Agar

15 g	Agar (Applichem, Germany)
1000 mL	Deionized water

- Nutrient Agar

15 g	Agar (Applichem, Germany)
3 g	Beef extract (Difco Laboratories, USA)
5 g	Peptone (Difco Laboratories, USA)
1000 mL	Deionized water

- Czapek Yeast Agar

15 g	Agar (Applichem, Germany)
30 g	Sucrose (Merck, Germany)
1 g	K_2HPO_4 (Applichem, Germany)
5 g	Yeast extract (Difco Laboratories, USA)
10 mL	Czapek solution*
1000 mL	Deionized water

*Czapek solution (devoid of iron)

30 g	$NaNO_3$ (Carlo Erba Reagents, Italy)
5 g	KCl (Merck, Germany)
5 g	$MgSO_4 \times 7H_2O$ (Carlo Erba Reagents, Italy)
100 mL	Deionized water

- Carnation Leaf Agar

15 g	Agar (Applichem, Germany)
1000 mL	Deionized water

Three fragments of carnation leaves, previously sterilized by exposing them to vapors of Propylene oxide for 2 hours, were added to each plate before the substrate solidification.

- Oat Meal Agar

15 g	Agar (Applichem, Germany)
40 g	Oat meal
1000 mL	Deionized water

- Richard's V8 medium

200 mL	V8 Vegetable juice (Campbell food, Belgium)
15g	Agar (Applichem, Germany)
10 g	Sucrose (Merck, Germany)
5 g	K_2HPO_4
0.02 g	$FeCl_3{:}6H_2O$
10 g	KNO_3
2.5 g	$MgSO_4{:}7H_2O$
1000 mL	Deionized water

- Czapek Dox Agar

20 g	Agar (Applichem, Germany)
30 g	Sucrose (Merck, Germany)
0.5 g	$MgSO_4$ (Carlo Erba Reagents, Italy)
0.5 g	KCl (Merck, Germany)
2 g	$NaNO_3$
1 g	KNO_3
3 g	FeSO4
1000 mL	Deionized water

- Richards Agar

20 g	Agar (Applichem, Germany)
50 g	Sucrose (Merck, Germany)
2.5 g	$MgSO_4$ (Carlo Erba Reagents, Italy)
10 g	KNO_3
0.02 g	$FeCl_3$
1000 mL	Deionized water

- Martin's Rose Bengal Agar

20 g	Agar (Applichem, Germany)
3 g	Glucose (Merck, Germany)
0.2 g	$MgSO_4$ (Carlo Erba Reagents, Italy)
0.15 g	KCl (Merck, Germany)
0.9 g	K_2HPO_4
1 g	NH_4NO_3
0.2 g	Rose Bengal
1000 mL	Deionized water

- Waksman's Glucose Agar

26 g	Agar (Applichem, Germany)
10 g	Glucose (Merck, Germany)
5 g	Peptone (Difco Laboratories, USA)
0.5 g	$MgSO_4$ (Carlo Erba Reagents, Italy)
1 g	KH_2PO_4
1000 mL	Deionized water

- Media B

18 g	Agar (Applichem, Germany)
1 g	$NH_4H_2PO_4$
0.2 g	$MgSO_4{:}7H_2O$ (Carlo Erba Reagents, Italy)
0.2 g	KCl (Merck, Germany)
1000 mL	Deionized water

The media B was corrected to pH 4.5 ± 0.5 by adding HCl or NaOH, and then autoclaved at 120°C, 1 atm, 20 min.

2.2.5 Sample isolation

Each crown sample was surface disinfected with 5% sodium hypochlorite for 2 min and subsequently rinsed in sterile water. The crown tissue was cut into different depth to four pieces after removing the outer layer as shown in figure 2-3. Three pieces of about 5 mm^2, were taken aseptically, and placed to dry on sterile filter paper under a sterile air flow and then was cut in additional five pieces transferred into Petri dishes, 9 cm in diameter, containing PDA^{+++} medium (table 2-2). The plates were incubated at 23-25°C for a period of 5/7 days, which is the average time needed for the growth of fungi present. Three plates of PDA^{+++} (table 2-2) were used for each sample and then the subculture was carried out to transfer and obtain pure cultures, which have been stored on PDA slants as well as in sterile water at 4°C.

Figure 2-3. Cutting the crown in order to isolate samples from different levels. (1-4) is the four pieces that was cut into different depth, (X) is the three pieces of about 5 mm^2.

2.2.6 Purification of samples

The isolated samples were periodically observed visually using the optical microscope in order to identify and count the different fungal forms. Representative colonies of the population were selected to transplant into new PDA plates. Small pieces of mycelium transferred onto PDA or MEA plates were incubated at 24°C and observed periodically in order to assess the purity of the isolates, and the transfers were repeated until reaching complete purification of different fungal colonies on different substrate media: PDA, PDA^{+++}, CYA, MEA, NA, CDA and WA. Pure cultures were obtained by excising hyphal tips from colony margins emerging from crown tissue.

2.2.7 Single-spore isolations and storage

Single-spore isolation was carried out using the procedure described by (Choi *et al.*, 1999) with modifications. When direct examination of the purified culture showed that the fungus was sporulating, a loop full of spore masses were picked up with a sterilized wire loop and resuspended in 10 ml of sterile distilled water as dilution-plate technique. Then, 1µl of spore suspension was spread onto the surface of four PDA plates 0.25µl each, and incubated overnight at 24°C. A single germinated spore was picked up with a sterilized needle and transferred onto a new PDA plate. In case of isolates that produced sterile mycelium without spores, a single germinate hypha was picked up with a sterilized needle under microscope and transferred onto a new PDA plate. All fungal isolates were coded with an alphanumeric acronym, which referred to the original plate and the origin of the sample. Pure cultures were stored at 4°C on PDA slants and in Eppendorf tubes containing sterile distilled water (Abang, 2003; Than *et al.*, 2008; Prihastuti *et al.*, 2009).

2.2.8 Sample identification based on morphological and cultural characters

Morphology and cultural characters of individual samples were studied on PDA, MEA and CYA. Fungal cultures were incubated at 24°C for 7 days and three cultures of every isolate were investigated. After 7 days, colony size, color of the conidial masses and zonation were recorded (Than *et al.*, 2008). Average increase in diameter was calculated by measuring the average of daily growth. Afterwards, the colonies were photographed and the isolates were grouped on the basis of growth rate, mycelium texture, and colony color. Slides were prepared for more detailed observation by taken in sterile way several mycelium fragments from the colony and mixed with a drop of distilled water. An optical microscope Orthoplan (Leitz, Germany) equipped with a digital camera Coolpix 4700 (Nikon, Japan)was used. The sizes of reproductive structures were observed and the shapes of conidia - if present - harvested from every culture of each isolate were recorded. Representative isolates were identified at genus level using different identification keys (Von Arx, 1974; Barnett and Hunter, 1998; Hanlin, 1998).

2.2.9 Identification based on molecular methods

2.2.9.1 Sample cultivation for DNA extraction

Representative isolates of each genus or species were grown on cellophane (Discocell PT60 - CELSA, Italy) to facilitate collection of the mycelium. Previously, the cellophane immersed in water was sterilized twice in autoclave, (121°C, 1 atm for 20 min) and it was placed on the surface of a PDA plate after cooling. The plates with the cellophane were left for two days at room temperature, in order to highlight the possible presence of microbial contaminants. After control, the isolates were inoculated by placing a piece of agar-mycelium taken from the edge of an actively growing fungal colony on the surface of cellophane. The plates were incubated at 24-25°C until complete colonization. Subsequently, the mycelium was collected and put into Eppendorf tubes, frozen at -25°C for two hours. Freeze dryer lyophilizer equipment EPD3 (Heto) was used to lyophilize the mycelium, which was ground to a powder using sterile sand to facilitate the operation (Rocchi *et al.*, 2010).

2.2.9.2 DNA extraction

The DNA was extracted from lyophilized mycelium following two procedures; 1) the EZNA Hp Plant Miniprep DNA KIT (Omega Bio-tek) was used according to the manufacturer's instructions, or 2) the (CTAB) method (Kelly *et al.*, 1998).

2.2.9.3 CTAB protocol

This protocol has been proposed by Kelly and colleagues (1998) for the extraction of DNA from fungal mycelium and plant tissues. It was modified in some parts depending on the practical use.

1. Weigh 30 mg of freeze-dried mycelium in Eppendorf tubes (1.5 mL).
2. Add 900 µL of CTAB buffer (Tris-HCI100 mM pH 7.5; 0.7M NaCl; 10 mM NaEDTA; CTAB 1% w / V) mixed with 1% (V / V) of 2-mercaptoethanol. The CTAB buffer should be heated to 60°C in a thermostatic bath before use.
3. Gently mix by inverting the microtube to homogenize the content.
4. Incubate the tubes at 60°C in a thermostatic bath for 30 minutes; gently mix by inverting the microtube from time to time (every 5-6 minutes).
5. Add 450 µL chloroform/isoamylalcohol (24:1) in the fume hood.
6. Shake the tubes using shaker for 5 minutes.
7. Spin in centrifuge for10 minutes with maximum speed (11000 rpm = 12000 g) at 4°C.
8. Carefully transfer the aqueous phase (above the white interface layer; ca. 300 µL) to a clean new microtube (1.5 mL) and discard the rest.
9. Add to the aqueous phase 0.1 volumes (30 µL) of a solution (10% CTAB, 0.7 M NaCl) preheated to 60°C.
10. Add 450 µL chloroform/isoamylalcohol (24: 1) in the fume hood.
11. Gently invert the microtube to be sure mixing is complete using shaker for 5 minutes.
12. Spin in centrifuge for10 minutes with maximum speed (11000 rpm = 12000 g) at 4°C.

13. Carefully transfer the aqueous phase to a clean new microtube (ca. 270 µL).
14. Add 1 volume (270 µL) of the precipitation buffer (Tris-HCl 50 mM pH 8.0; CTAB 1% w / v; 10 mM NaEDTA).
15. Gently invert the microtube to be sure mixing is complete.
16. Incubate for 30 minutes at room temperature to permit precipitation of the DNA.
17. Spin in centrifuge for10 minutes with maximum speed (11500 rpm = 13000 g) at 4°C to pellet the DNA.
18. Remove the supernatant carefully and gently.
19. Re-suspend the pellet in 450 µL of 1 M NaCl.
20. Add 2 volumes (900 µL) of 100% ethanol.
21. Store the microtube for at least 90 minutes at -20°C.
22. Spin in centrifuge for 20 minutes with maximum speed (13000 rpm = 16000 g) at 4°C to pellet the DNA.
23. Remove the supernatant carefully and gently.
24. Wash the pellet once by adding 1 mL of ethanol 70%, without shaking the tubes.
25. Spin in centrifuge for 10 minutes with maximum speed (13000 rpm = 16000 g) at 4°C.
26. Remove the supernatant carefully and dry the pellet by leaving tube open in the inverted position on a piece of filter paper to remove all liquid phase.
27. Freeze the pellets obtained, lyophilize for two hours, and store the freeze-dried pellet at -25°C.
28. Suspend the DNA pellet in sterile H_2O 70 µL before use or elution buffer in case of a commercial kit was used and store at -25°C.

The concentration of nucleic acid was estimated by Qbit analyser (Invitrogen, USA).

2.2.10 Quantification of extracted DNA

Part of DNA concentration in the extracts was determined using a fluorometer Qubit ™ kit and the Quant-iT ™ "dsDNA HS Assay Kit" (Invitrogen ™) according the instruction given by the producer. For each sample were carried out three readings and subsequently based on the values obtained, the suspensions of DNA were brought to a concentration of approximately 5 mg / ml in 100 µl with sterile water.

2.2.11 PCR amplification

2.2.11.1 Internal transcribed spacer (ITS) region

The primers ITS1 and ITS4 (White *et al.*, 1990) were used to amplify ITS-1 - 5.8S - ITS-2 region of the nuclear rDNA (Figure 2-4). PCR was performed in 30-µl volume containing 1xGoTaq Reaction Buffer (Promega, USA) with 1.5 mM of $MgCl_2$, 0.1 mM of each dNTP, 0.1 µM of each primer, 0.9 units of Taq DNA polymerase (Promega, USA), and at least 1 ng of genomic DNA (table 2-3). For the ITS region, PCR reaction was performed in a Gene Cycler (Biorad, USA) using an initial cycle of denaturation at 95°C for 2 min, 25 cycles of denaturation at 95°C for 30 sec, annealing at 55°C for 30 sec, extension at 72°C for 1 min, and final extension at 72°C for 10 min.

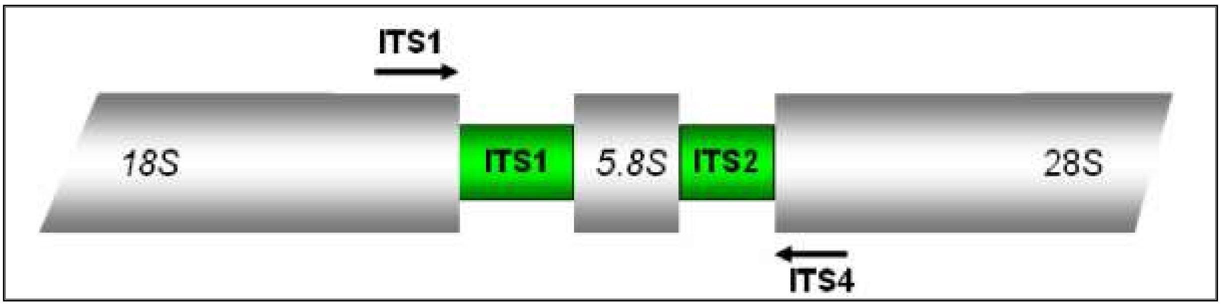


Figure 2-4. Location of the DNA genes of the ribosomal subunits, indicate the spacer regions and ITS primers used in the amplification.

Table 2-3. Preparation of 30 µl PCR reaction and the sequence of ITS primers used.

	concentration				**µl for one sample**	**unit**
	stock	**unit**	**reaction**	**unit**		
GO TAQ	5	U/µl	0.9	U	0.18	µl
Buffer	5	x	1	x	6	µl
DNTP mix	2.5	mM	0.1	mM	1.2	µl
primer forward	50	µM	1	µM	0.6	µl
primer reverse	50	µM	1	µM	0.6	µl
DD water					20.22	µl
DNA					1.2	µl
sequence 5` → 3` of ITS1		TCC GTA GGT GAA CCT GCG G				
sequence 5` → 3` of ITS4		TCC TCC GCT TAT TGA TAT GC				

2.2.11.2 The region of β-tubulin gene

The amplification of the region of the β-tubulin was carried out using specific primers that bind in the sequences of the introns (Figure 2-5) (Glass and Donaldson, 1995). For

Fusarium and *Lasiodiplodia,* primers pairs BT1a, BT1b and BT2a, BT2b were used (Hyde *et al.*, 2014). PCR was performed in 30 µl volume using the same conditions and reactions as for ITS primers (table 2-4).

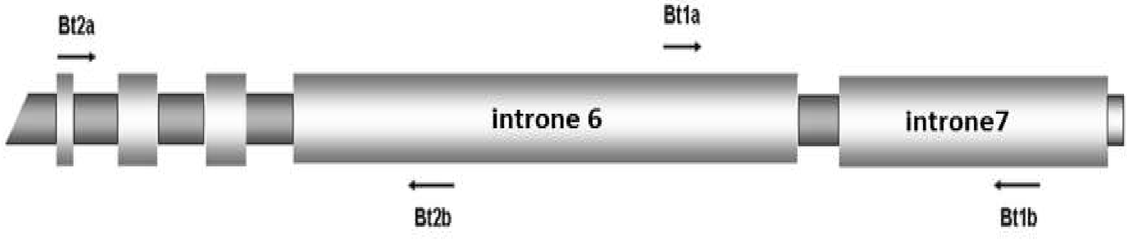


Figure 2-5. Location of the DNA genes of the regions of β-tubulin gene and primers used in the amplification.

Table 2-4. Preparation of 30 µl PCR reaction and the sequence of β-tubulin primers used.

	concentration				**µl for one sample**	**unit**
	stock	**unit**	**reaction**	**unit**		
GO TAQ	5	U/µl	0.9	U	0.18	µl
Buffer	5	x	1	x	6	µl
DNTP mix	2.5	mM	0.1	mM	1.2	µl
primer forward	50	µM	1	µM	0.6	µl
primer reverse	50	µM	1	µM	0.6	µl
DD water					20.22	µl
DNA					1.2	µl
sequence 5` → 3` of BT1a	TTC CCC CGT CTC CAC TTC TTC ATG					
sequence 5` → 3` of BT1b	GAC GAG ATC GTT CAT GTT GAA CTC					
sequence 5` → 3` of BT2a	GGT AAC CAA ATC GGT GCT GCT TTC					
sequence 5` → 3` of BT2b	ACC CTC AGT GTA GTG ACC CTT GGC					

2.2.11.3 The translation elongation factor 1-α (TEF)

The translation elongation factor 1-α gene was used for PCR amplification of *Fusarium* samples using primer pair TEF1T and TEF2T (Figure 2-6) (O'Donnell *et al.*, 1998; Geiser *et al.*, 2004; Nitschke *et al.*, 2009; Sampietro *et al.*, 2010; Hyde *et al.*, 2014). PCR reactions were performed in a total volume of 25 µl (table 2-5) containing 100 ng of genomic DNA, 10 mM Tris–HCl (pH 9), 0.1% Triton X-100, 100 µM dNTPs, 1mM $MgCl_2$, 1 unit of GoTaq polymerase (Promega, USA) and 2 µM of each primer, TEF1T and TEF2T. The PCR reaction was done in a Gene Cycler (Biorad, USA) using the following program: initial denaturation at 94°C for 5 minutes, followed by 35 cycles at 94°C for 30 seconds, annealing at 61°C for 45 seconds, and extension at 72°C for 1 minute. Final extension at 72°C for 5 min (Hoffman and Winston, 1987).

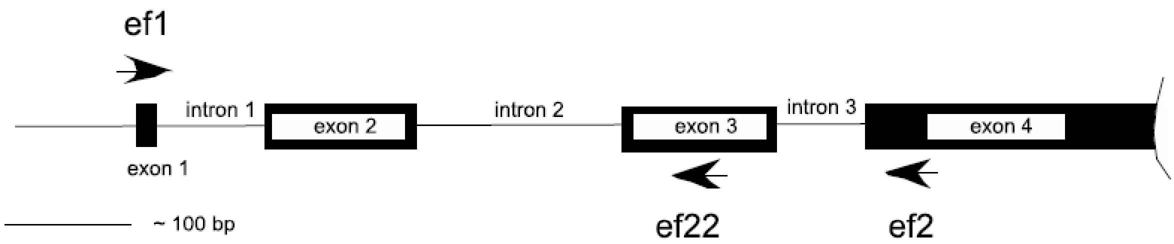


Figure 2-6. Location of different primers of the TEF gene region in Fusarium.

Table 2-5. Preparation of 25 µl PCR reaction and the sequence of TEF primers used.

	concentration				**µl for one sample**	**unit**
	stock	**unit**	**reaction**	**unit**		
GO TAQ	5	U/µl	0.8	U	0.16	µl
Buffer	5	x	1	x	5	µl
DNTP mix	2.5	mM	0.2	mM	2	µl
Triton X-100	10	%	0.1	%	0.25	µl
Tris-HCL pH-9	1000	mM	10	mM	0.25	µl
MgCl2	25	mM	1	mM	1	µl
primer forward	50	µM	0.4	µM	0.2	µl
primer reverse	50	µM	0.4	µM	0.2	µl
DD water					14.74	µl
DNA					1.2	µl
sequence 5` → 3` of TEF1	ATG GGT AAG GAG GAC AAG AC					
sequence 5` → 3` of TEF2	GGA AGT ACC AGT GAT CAT GTT					
sequence 5` → 3` of TEF22	AGG AAC CCT TAC CGA GCT C					

2.2.11.4 The intergenic region of apn2 and MAT1-2-1 genes (ApMat)

For *Colletotrichum*, the amplification of intergenic region of apn2 and MAT1-2-1 genes was carried out using specific primers pares AMF and AMR (Figure 2-7) (Silva *et al.*, 2012; Sharma *et al.*, 2013; Hyde *et al.*, 2014). PCR was performed as described above, in 30-µl volume containing different concentration as reported in (table 2-6). Reactions were performed in a Gene Cycler (Biorad, USA) using an initial cycle of denaturation of 3 min at 94°C followed by 30 cycles of 45 s at 94°C, 45 s at 62°C and 1 min at 72°C, with a final extension of 7 min at 72°C.

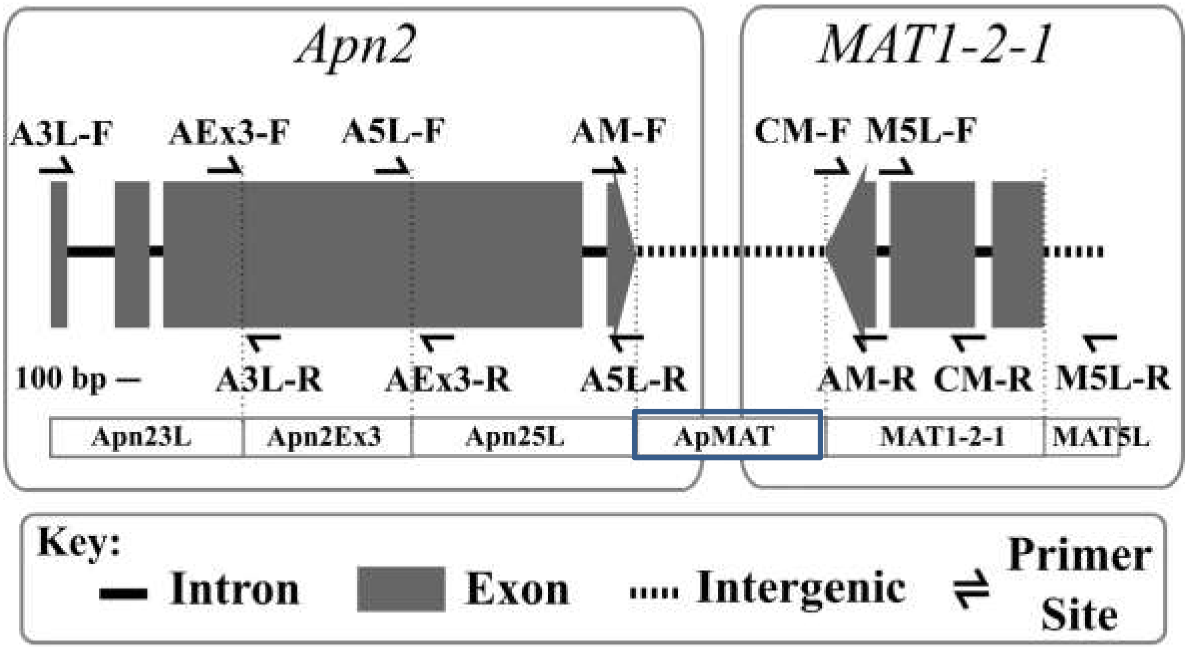


Figure 2-7. Location of different primers on Apn2/MAT locus map.

Table 2-6. Preparation of 30 µl PCR reaction and the sequence of ApMat primers used.

	concentration				µl for one sample	unit
	stock	unit	reaction	unit		
GO TAQ	5	U/µl	2	U	0.4	µl
Buffer	5	x	1	x	6	µl
DNTP mix	2.5	mM	0.2	mM	2.4	µl
primer forward	50	µM	0.8	µM	0.48	µl
primer reverse	50	µM	0.8	µM	0.48	µl
DD water					17.84	µl
DNA					2.4	µl
sequence 5` → 3` of AMF	TCA TTC TAC GTA TGT GCC CG					
sequence 5` → 3` of AMR	CCA GAA ATA CAC CGA ACT TGC					

2.2.11.5 The glyceraldehyde-3-phosphate dehydrogenase gene (GPDE)

The GPDE region in the genus *Curvularia* was amplified using primers pairs GPDEF and GPDER (Berbee *et al.*, 1999; Câmara *et al.*, 2002; Hyde *et al.*, 2014). The PCR was performed in 30-µl volume as described above. Reactions were performed in a Gene Cycler (Biorad, USA) using an initial cycle of denaturation of 2 min at 94°C followed by 35 cycles of 94°C for 30s, 57°C for 1 min, 72°C for 1.5 min, and a final extension at 72°C for 3 min.

Table 2-7. Preparation of 30 µl PCR reaction and the sequence of GPDE primers used.

	concentration				µl for one sample	unit
	stock	unit	one reaction	unit		
GO TAQ	5	U/µl	0.9	U	0.18	µl
Buffer	5	x	1	x	6	µl
DNTP mix	2.5	mM	0.1	mM	1.2	µl
primer forward	50	µM	1	µM	0.6	µl
primer reverse	50	µM	1	µM	0.6	µl
DD water					20.22	µl
DNA					1.2	µl
sequence 5` → 3` of GPDEF		TCA TTC TAC GTA TGT GCC CG				
sequence 5` → 3` of GPDER		CCA GAA ATA CAC CGA ACT TGC				

2.2.12 Electrophoresis and the analysis of bands

The PCR products were visualized in 1.5% agarose gel to evaluate the presence and size of PCR products. The concentrated solution of 50x TAE (Tris-Acetate-EDTA) (Tris-HCl, 2 M, NaEDTA 0:05 M adjusted to pH 8.0 by adding an appropriate amount of glacial acetic acid (about 60 mL)) was used to prepare 1x TAE buffer solution which used for the preparation of the gel as well as for electrophoretic run. The agarose powder mixed with TAE buffer was brought to boil in order to fully dissolves, then it has been cooled to 55°C, with stirring. The gel was poured and the replacement of the comb allowed to present wells 3 or 6 mm in length after the solidification 30-45 minutes. Then it was transferred inside an electrophoresis cell powered by a multiple power supply PowerPac 300 (BIO-RAD Laboratories, USA). Different amplified PCR products were loaded (4 µL of PCR product and 2 µL of thickener / dye (aqueous solution at 30% of glycerol and 0.025% bromophenol blue)) in wells 3 mm. All runs have been made in electric field at constant voltage (3V / cm) for a variable time (2 hours) depending on the type of analysis.

It was stained by immersion for 20-30 minutes in ethidium bromide (0.5 g / mL in aqueous solution), followed by washing for 5 minutes in deionized water. The visualization of the bands was obtained using a transilluminator GEL DOC 2000 (BIO-RAD Laboratories, USA) at UV light. Digital images have been scanned and processed with the Quantity One program that comes with the same transilluminator and stored in Tag Image File Format (TIFF) for further use. Data on the individual bands were collected in spreadsheets. Examples of different digital images were shown in (Annex B- from 1 to 6).

2.2.13 DNA Sequencing

Amplicons subjected to sequencing were purified from the residues of the amplification process with QlAquick PCR Purification Kit (Qiagen, USA) and then sent to an external laboratory, Eurofins genomics (Vimodrone, Italy) with one primer used for the amplification as follows: ITS1 was used in case of ITS amplification, BT2a with β-tubulin, TEF1T with TEF gene, AMF with ApMat and GPDEF in case of GPDE gene. The Chromas programme, version 1.45 (McCarthy 1998), was used to assemble and edit the sequences. Nucleotide collection nr/nt database from BLAST GenBank online database was used to compare the sequences obtained with those deposited for prokaryotes and fungi, and the FUSARIUM-ID v. 1.0 sequence database for identifying some *Fusarium* strains. Sequence homology higher than 98% was used to assume sequence identity and molecular identification. The nucleotide sequences of all representatives strains were shown in (Annex A-1).

2.3 Results and discussion

Out of 558 banana hands analyzed, a total of 5000 fungal colonies were obtained from crown tissue samples, 1750 representative colonies were purified, and 518 representative colonies were characterized and identified using morphological and molecular methods (table 2-8). Fungi were found and isolated from all analyzed samples that were collected from various stages of banana processing, starting from field until shipping (figure 1-20). More than one fungal colony was seldom isolated from one crown fragment (figure 2-8) and we purified most of the colonies developed (figure 2-9). The fungal community was composed mostly by *Fusarium* spp., and strains belonging to eight less frequent genera. Additionally, different genera considered saprophytic or contaminants from other resources were isolated (figure 2-10).

Figure 2-8. Variety of fungal colonies developed from crown fragments and more than one colony was seldom isolated from same fragment.

Figure 2-9. Purified fungal colonies.

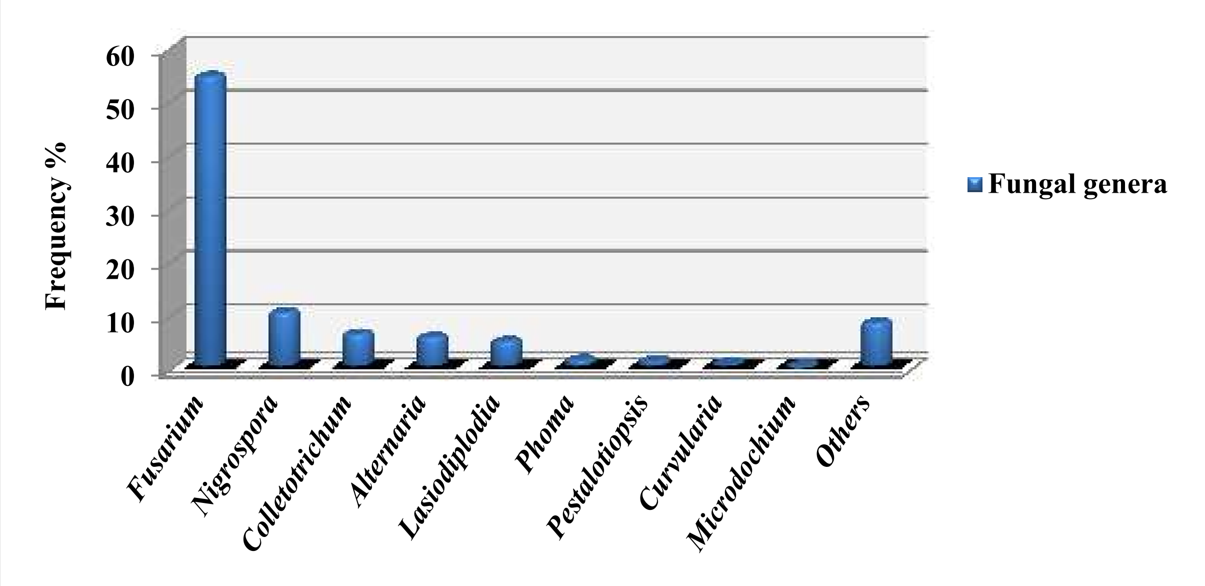


Figure 2-10. The frequency of fungal genera isolated and associated with crown rot disease.

Fusarium was the most frequent genus, equal to 55% of all isolated fungi, and it was found in more than 80% of all analyzed samples. The 285 *Fusarium* isolates representative of nine species were dominated by *Fusarium incarnatum-equiseti* species complex (53%), followed by *F. verticillioides* (Sacc.) (12%) and *F. sacchari* (E.J. Butler & Hafiz Khan) (12%), then by *F. proliferatum* (Matsush.) (7%), and *F. solani* (Mart.) (6%, figure 2-11, 2-12). The detailed analysis of the *Fusarium* genus is described in chapter 5.

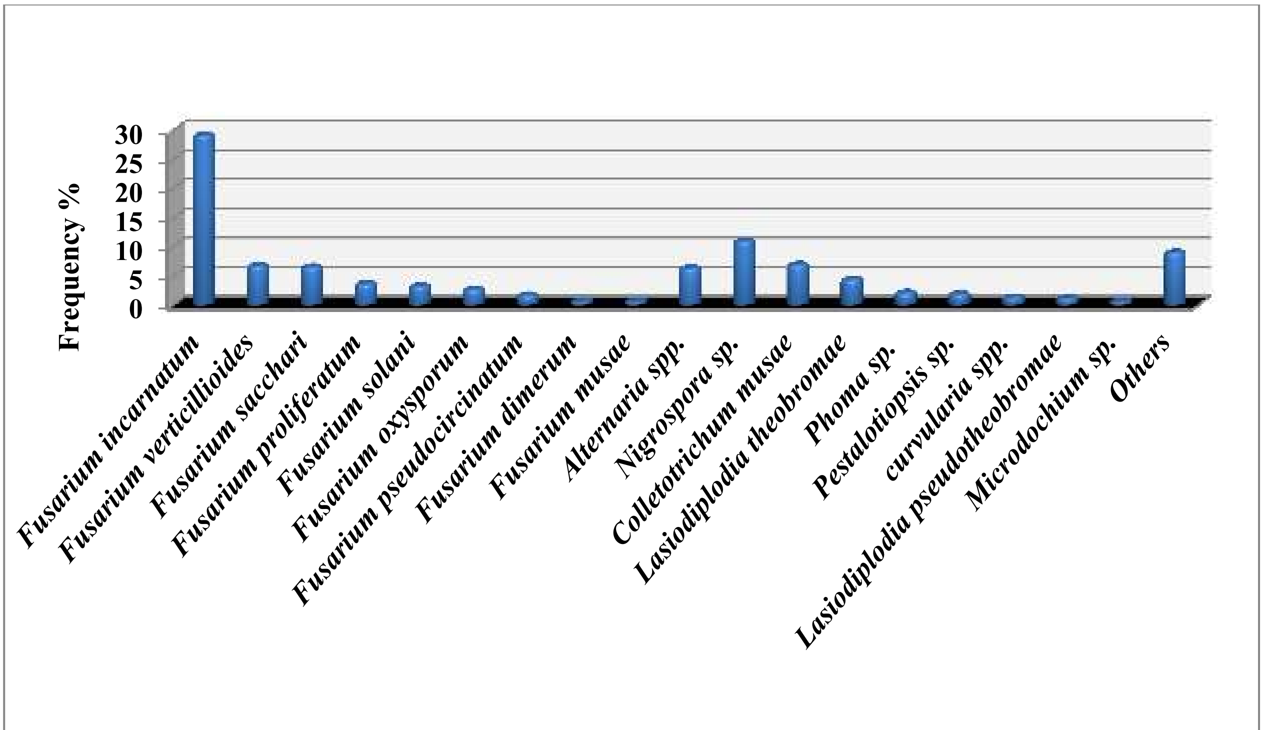


Figure 2-11. The frequency of different fungal species associated with crown rot disease.

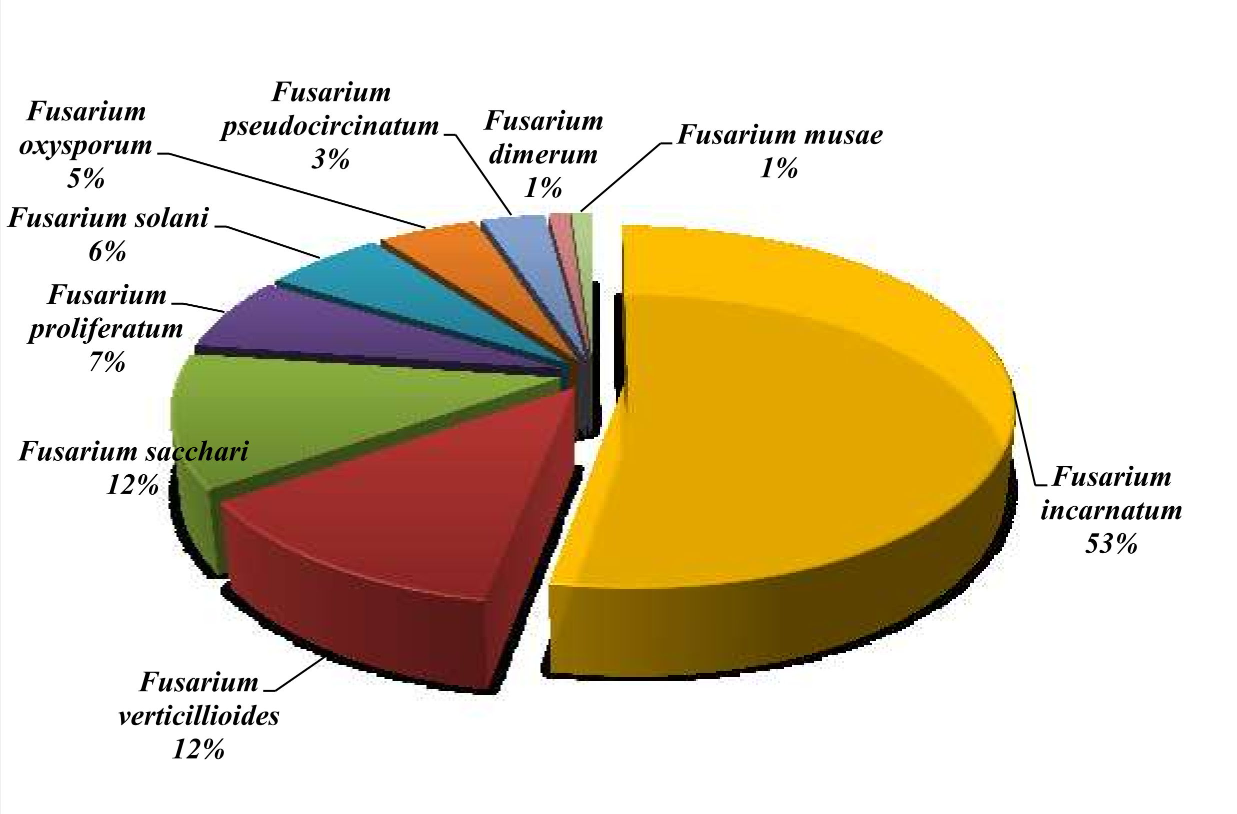


Figure 2-12. The frequency of Fusarium species associated with crown rot disease.

The second most frequent genus was *Colletotrichum,* accounting for 7% of isolated strains, and found in 13% of all samples; principally identified as *C. musae* (Berk. & M.A. Curtis) Arx. (see chapter 6). All *C. musae* isolates were isolated from crown tissues and mainly from internal crown tissues. Other strains belonged to *Lasiodiplodia* spp. (Ellis & Everh), accounted for 6% found in 7% of all samples (see chapter 7) and were isolated mainly from crown's outer tissues. We identified two species belonging to this genus; *L. theobromae* (Pat.) Griffon & Maubl. and *L. pseudotheobromae* (A.J.L. Phillips, A. Alves & Crous) (figure 2-13).

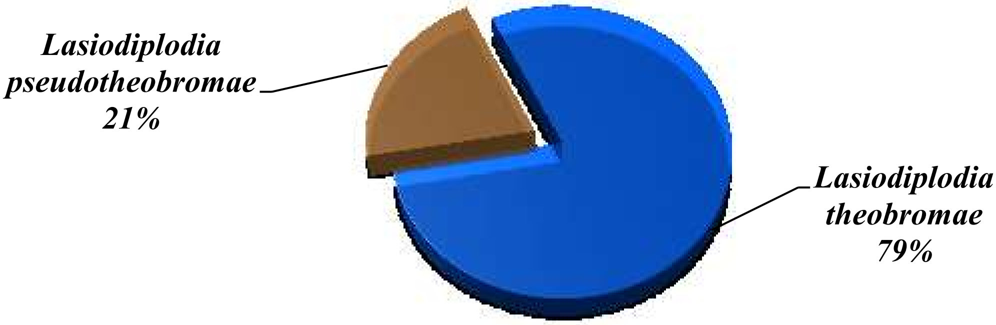


Figure 2-13. The frequency of Lasiodiplodia species associated with crown rot disease.

The other isolated fungi were: *Nigrospora* sp. (Zimm) 11%, *Alternaria* spp. (Nees) 6%, *Phoma* spp. (Sacc) 2%, *Pestalotiopsis* sp. (Steyaert) 2%, *Curvularia* spp. (Boedijn) 1% and *Microdochium* sp. (Syd. & P. Syd) 1%. The molecular analysis confirmed the morphological identification, and moreover identified the sample on the species level, not just the genus (figure 2-11).

Table 2-8. Identification of representative strains, isolated from crown tissues, based on their ITS sequences compared with the reference sequence of highest similarity existing on Blast GenBank online database.

Strains	Identified Taxa	Similarity	Accession number
D113	*Alternaria alternata*	99%	KF193470.1
B09	*Alternaria tenuissima*	99%	JX156349.1
C2-1	*Colletotrichum* spp.	99%	HQ264183.1
C3-1	*Colletotrichum* spp.	99%	JX010142.1
D128	*Colletotrichum* spp.	99%	JX010140.1
F41	*Curvularia* spp.	99%	HE861844.1
F34	*Fusarium* spp.	99%	GQ149770.1
D67	*Fusarium* spp.	99%	AB693912.1
D41	*Fusarium* spp.	100%	JQ690082.1
F30	*Fusarium* spp.	99%	JN235540.1
B11	*Fusarium* spp.	99%	HQ332532.1
A16	*Fusarium* spp.	99%	HQ718415.1
D221	*Fusarium* spp.	99%	JN624887.1
C4-4	*Fusarium* spp.	99%	KF541096.1
D187	*Fusarium* spp.	99%	FR691772.1
C2-2	*Fusarium* spp.	99%	DQ297570.1
B01	*Fusarium* spp.	99%	GU257903.1
D89	*Lasiodiplodia* spp.	100%	FJ904838.1
A13	*Lasiodiplodia* spp.	99%	JX868613.1
A07	*Microdochium* sp.	98%	JN601149.1
D100	*Nigrospora* sp.	99%	JN207248.1
F35	*Nigrospora* sp.	99%	JN207298.1
F22	*Pestalotiopsis* sp.	99%	GU723442.1
D134	*Phoma* sp.	99%	HQ630963.1

The representative strains were further used for pathogenicity tests (described in chapter 3), which allowed us to reproduce the crown rot symptoms and to calculate the disease incidence (DI) and disease severity (DSI) using crown rot index scale of 0 - 7.

Table 2-9. The origin of all identified isolates.

N°	Code	Origin	Identification results
1	D25	Crown from field	*Acremonum* sp.
2	D38	Crown tissues taken after dehanding tank	*Acremonum* sp.
3	D55	Crown tissues taken at washing bunches	*Acremonum* sp.
4	D95	Crown tissues taken at washing bunches	*Acremonum* sp.
5	D113	Crown tissues taken after dehanding tank	*Alternaria alternata*
6	F46	Crown tissues taken after Alum treatment	*Alternaria alternata*
7	F47	Crown tissues taken after Alum treatment	*Alternaria porri*
8	D111	Crown from boxes	*Alternaria* sp.
9	D112	Crown debris	*Alternaria* sp.
10	D114	Crown tissues taken after Alum treatment	*Alternaria* sp.
11	D115	Crown tissues taken at washing bunches	*Alternaria* sp.
12	D116	Crown debris	*Alternaria* sp.
13	D233	Crown from field	*Alternaria* sp.
14	D238	Crown from field	*Alternaria* sp.
15	D249	Crown from field	*Alternaria* sp.
16	D252	Crown from field	*Alternaria* sp.
17	D257	Crown tissues taken after second tank	*Alternaria* sp.
18	D258	Crown from field	*Alternaria* sp.
19	D259	Crown from field	*Alternaria* sp.
20	D261	Crown from field	*Alternaria* sp.
21	D265	Crown from field	*Alternaria* sp.
22	SD360	Outer layer crown tissues taken after packaging	*Alternaria* sp.
23	D363	Crown tissues taken at washing bunches	*Alternaria* sp.
24	D460	Internal crown tissues taken after packaging	*Alternaria* sp.
25	D515	Internal crown tissues taken after packaging	*Alternaria* sp.
26	D551	Crown tissues taken at washing bunches	*Alternaria* sp.
27	E07	Symptomatic crown tissues	*Alternaria* sp.
28	E12	Symptomatic crown tissues	*Alternaria* sp.
29	H32	Crown from field	*Alternaria* sp.
30	H33	Flowers	*Alternaria* sp.
31	H34	Crown tissues taken at washing bunches	*Alternaria* sp.
32	H35	Crown tissues taken after dehanding tank	*Alternaria* sp.
33	H36	Crown tissues taken after dehanding tank	*Alternaria* sp.
34	H37	Crown from field	*Alternaria* sp.
35	I12	Crown from field	*Alternaria* sp.
36	I13	Crown from field	*Alternaria* sp.
37	B09	Crown tissues taken at washing bunches	*Alternaria tenuissima*
38	D234	Crown from field	*Arthrinium xenocordella*
39	D18	Crown debris	*Botryotinia fuckeliana*

N°	Code	Origin	Identification results
40	C4-5	Symptomatic crown tissues	*Candida orthopsilosis*
41	D264	Crown tissues taken after second tank	*Cladiosporum* sp.
42	D272	Crown from field	*Cladiosporum* sp.
43	B3	Symptomatic crown tissues	*Cladosporium oxysporum*
44	C3-1	Symptomatic crown tissues	*Colletotrichum musae*
45	C4-2	Symptomatic crown tissues	*Colletotrichum musae*
46	D1026	Internal crown tissues taken after packaging	*Colletotrichum musae*
47	D1027	Internal crown tissues taken after packaging	*Colletotrichum musae*
48	D128	Crown tissues taken after dehanding tank	*Colletotrichum musae*
49	D144	Crown tissues taken after dehanding tank	*Colletotrichum musae*
50	D147	Crown from boxes	*Colletotrichum musae*
51	D148	Crown from boxes	*Colletotrichum musae*
52	D149	Crown from boxes	*Colletotrichum musae*
53	D150	Crown from boxes	*Colletotrichum musae*
54	D153	Crown tissues taken after dehanding tank	*Colletotrichum musae*
55	D154	Crown tissues taken after dehanding tank	*Colletotrichum musae*
56	D155	Flowers	*Colletotrichum musae*
57	D157	Crown from field	*Colletotrichum musae*
58	D169	Crown tissues taken after dehanding tank	*Colletotrichum musae*
59	D177	Crown tissues taken at washing bunches	*Colletotrichum musae*
60	D355	Internal crown tissues taken after packaging	*Colletotrichum musae*
61	D356	Internal crown tissues taken after packaging	*Colletotrichum musae*
62	SD361	Internal crown tissues taken after packaging	*Colletotrichum musae*
63	D443	Internal crown tissues taken after packaging	*Colletotrichum musae*
64	D48	Internal crown tissues taken after packaging	*Colletotrichum musae*
65	D490	Internal crown tissues taken after packaging	*Colletotrichum musae*
66	D527	Internal crown tissues taken after packaging	*Colletotrichum musae*
67	D530	Internal crown tissues taken after packaging	*Colletotrichum musae*
68	D552	Internal crown tissues taken after packaging	*Colletotrichum musae*
69	D57	Internal crown tissues taken after packaging	*Colletotrichum musae*
70	D570	Internal crown tissues taken after packaging	*Colletotrichum musae*
71	D598	Internal crown tissues taken after packaging	*Colletotrichum musae*
72	D817	Internal crown tissues taken after packaging	*Colletotrichum musae*
73	D974	Internal crown tissues taken after packaging	*Colletotrichum musae*
74	H27	Crown tissues taken after dehanding tank	*Colletotrichum musae*
75	H28	Crown tissues taken at washing bunches	*Colletotrichum musae*
76	H29	Crown tissues taken after second tank	*Colletotrichum musae*
77	H30	Crown tissues taken at dehanding.	*Colletotrichum musae*
78	H31	Crown tissues taken at dehanding.	*Colletotrichum musae*
79	C2-1	Symptomatic crown tissues	*Colletotrichum tropicale*

N°	Code	Origin	Identification results
80	D216	Crown from boxes	*Contamination*
81	D199	Crown tissues taken at washing bunches	*Coprinellus radians*
82	F12	Crown tissues taken after dehanding tank	*Coprinellus radians*
83	D200	Crown tissues taken after dehanding tank	*Corynespora cassiicola*
84	D124	Flowers	*Curvularia hawaiiensis*
85	D135	Crown debris	*Curvularia hawaiiensis*
86	F41	Crown tissues taken after second tank	*Curvularia lunata*
87	D104	Crown from field	*Curvularia* sp.
88	D105	Crown tissues taken at washing bunches	*Curvularia* sp.
89	D121	Crown from boxes	*Curvularia* sp.
90	D122	Crown from field	*Curvularia* sp.
91	D50	Crown tissues taken after dehanding tank	*Diaporthe phaseolorum*
92	D126	Flowers	*Exserohilum rostratum*
93	D597	Crown tissues taken at washing bunches	*Fusarium dimerum*
94	F30	Crown tissues taken at dehanding.	*Fusarium dimerum*
95	SD01	Crown tissues taken at packaging	*Fusarium dimerum*
96	A15	Symptomatic crown tissues	*Fusarium incarnatum*
97	A16	Symptomatic crown tissues	*Fusarium incarnatum*
98	B05	Symptomatic crown tissues	*Fusarium incarnatum*
99	B11	Symptomatic crown tissues	*Fusarium incarnatum*
100	B12	Symptomatic crown tissues	*Fusarium incarnatum*
101	C1-5	Symptomatic crown tissues	*Fusarium incarnatum*
102	D117	Crown from boxes	*Fusarium incarnatum*
103	D143	Crown tissues taken after second tank	*Fusarium incarnatum*
104	D156	Flowers	*Fusarium incarnatum*
105	D166	Crown debris	*Fusarium incarnatum*
106	D181	Crown tissues taken at dehanding.	*Fusarium incarnatum*
107	D196	Crown from boxes	*Fusarium incarnatum*
108	D198	Crown from boxes	*Fusarium incarnatum*
109	D20	Crown tissues taken after dehanding tank	*Fusarium incarnatum*
110	D210	Crown from field	*Fusarium incarnatum*
111	D227	Crown tissues taken after dehanding tank	*Fusarium incarnatum*
112	D23	Flowers	*Fusarium incarnatum*
113	D239	Crown from field	*Fusarium incarnatum*
114	D253	Crown from field	*Fusarium incarnatum*
115	D277	Crown from field	*Fusarium incarnatum*
116	D358	Outer layer crown tissues taken after packaging	*Fusarium incarnatum*
117	D361	Internal crown tissues taken after packaging	*Fusarium incarnatum*
118	D362	Crown tissues taken at packaging	*Fusarium incarnatum*
119	D41	Crown tissues taken after dehanding tank	*Fusarium incarnatum*

N°	Code	Origin	Identification results
120	D442	Internal crown tissues taken after packaging	*Fusarium incarnatum*
121	D466	Internal crown tissues taken after packaging	*Fusarium incarnatum*
122	D487	Outer layer crown tissues taken after packaging	*Fusarium incarnatum*
123	D492	Internal crown tissues taken after packaging	*Fusarium incarnatum*
124	D504	Internal crown tissues taken after packaging	*Fusarium incarnatum*
125	D505	Internal crown tissues taken after packaging	*Fusarium incarnatum*
126	D51	Crown tissues taken after second tank	*Fusarium incarnatum*
127	D532	Internal crown tissues taken after packaging	*Fusarium incarnatum*
128	D538	Internal crown tissues taken after packaging	*Fusarium incarnatum*
129	D58	Crown tissues taken at dehanding.	*Fusarium incarnatum*
130	D596	Internal crown tissues taken after packaging	*Fusarium incarnatum*
131	D60	Crown from field	*Fusarium incarnatum*
132	D64	Crown tissues taken at dehanding.	*Fusarium incarnatum*
133	D67	Crown from field	*Fusarium incarnatum*
134	D71	Crown tissues taken after second tank	*Fusarium incarnatum*
135	SD817	Outer layer crown tissues taken after packaging	*Fusarium incarnatum*
136	SD974	Outer layer crown tissues taken after packaging	*Fusarium incarnatum*
137	E01	Symptomatic crown tissues	*Fusarium incarnatum*
138	E03	Symptomatic crown tissues	*Fusarium incarnatum*
139	E08	Symptomatic crown tissues	*Fusarium incarnatum*
140	F17	Crown tissues taken after dehanding tank	*Fusarium incarnatum*
141	F19	Crown tissues taken at dehanding.	*Fusarium incarnatum*
142	F20	Crown tissues taken at dehanding.	*Fusarium incarnatum*
143	F21	Crown tissues taken at dehanding.	*Fusarium incarnatum*
144	F34	Crown tissues taken after dehanding tank	*Fusarium incarnatum*
145	H01	Crown from field	*Fusarium incarnatum*
146	H02	Flowers	*Fusarium incarnatum*
147	H04	Crown tissues taken at packaging	*Fusarium incarnatum*
148	H05	Crown tissues taken at dehanding.	*Fusarium incarnatum*
149	H06	Crown from field	*Fusarium incarnatum*
150	H07	Crown tissues taken after Alum treatment	*Fusarium incarnatum*
151	H08	Crown tissues taken at packaging	*Fusarium incarnatum*
152	H09	Crown tissues taken at packaging	*Fusarium incarnatum*
153	H10	Crown tissues taken after dehanding tank	*Fusarium incarnatum*
154	H11	Crown tissues taken at dehanding.	*Fusarium incarnatum*
155	H13	Flowers	*Fusarium incarnatum*
156	I18	Flowers	*Fusarium incarnatum*
157	I19	Flowers	*Fusarium incarnatum*
158	I20	Crown tissues taken after dehanding tank	*Fusarium incarnatum*
159	I21	Crown tissues taken after dehanding tank	*Fusarium incarnatum*

N°	Code	Origin	Identification results
160	I22	Crown tissues taken at dehanding.	*Fusarium incarnatum*
161	I23	Crown tissues taken at packaging	*Fusarium incarnatum*
162	I24	Crown tissues taken after dehanding tank	*Fusarium incarnatum*
163	I25	Crown tissues taken after second tank	*Fusarium incarnatum*
164	I26	Crown tissues taken after dehanding tank	*Fusarium incarnatum*
165	I27	Crown tissues taken after dehanding tank	*Fusarium incarnatum*
166	I28	Crown tissues taken after second tank	*Fusarium incarnatum*
167	SD02	Crown tissues taken at packaging	*Fusarium incarnatum*
168	SD03	Crown tissues taken at packaging	*Fusarium incarnatum*
169	SD04	Crown tissues taken at packaging	*Fusarium incarnatum*
170	SD06	Crown tissues taken at packaging	*Fusarium incarnatum*
171	SD07	Crown tissues taken at packaging	*Fusarium incarnatum*
172	SD08	Crown tissues taken at packaging	*Fusarium incarnatum*
173	SD09	Crown tissues taken at packaging	*Fusarium incarnatum*
174	SD10	Crown tissues taken at packaging	*Fusarium incarnatum*
175	SD1000	Internal crown tissues taken after packaging	*Fusarium incarnatum*
176	SD1001	Crown tissues taken at washing bunches	*Fusarium incarnatum*
177	SD1002	Crown tissues taken at washing bunches	*Fusarium incarnatum*
178	SD1015	Internal crown tissues taken after packaging	*Fusarium incarnatum*
179	SD1020	Internal crown tissues taken after packaging	*Fusarium incarnatum*
180	SD1021	Crown tissues taken at washing bunches	*Fusarium incarnatum*
181	SD1036	Outer layer crown tissues taken after packaging	*Fusarium incarnatum*
182	SD1037	Outer layer crown tissues taken after packaging	*Fusarium incarnatum*
183	SD1038	Crown tissues taken at washing bunches	*Fusarium incarnatum*
184	SD12	Crown tissues taken at washing bunches	*Fusarium incarnatum*
185	SD13	Crown tissues taken at washing bunches	*Fusarium incarnatum*
186	SD139	Crown tissues taken at washing bunches	*Fusarium incarnatum*
187	SD14	Crown tissues taken at washing bunches	*Fusarium incarnatum*
188	SD140	Crown tissues taken at washing bunches	*Fusarium incarnatum*
189	SD141	Crown tissues taken at washing bunches	*Fusarium incarnatum*
190	SD142	Crown tissues taken at washing bunches	*Fusarium incarnatum*
191	SD145	Crown tissues taken at washing bunches	*Fusarium incarnatum*
192	SD15	Crown tissues taken at washing bunches	*Fusarium incarnatum*
193	SD151	Crown tissues taken at washing bunches	*Fusarium incarnatum*
194	SD159	Crown tissues taken at pakaging	*Fusarium incarnatum*
195	SD16	Crown tissues taken at pakaging	*Fusarium incarnatum*
196	SD160	Crown tissues taken at pakaging	*Fusarium incarnatum*
197	SD161	Crown tissues taken at pakaging	*Fusarium incarnatum*
198	SD162	Crown tissues taken at pakaging	*Fusarium incarnatum*
199	SD163	Crown tissues taken at pakaging	*Fusarium incarnatum*

N°	Code	Origin	Identification results
200	SD165	Crown tissues taken at pakaging	*Fusarium incarnatum*
201	SD167	Crown tissues taken at pakaging	*Fusarium incarnatum*
202	SD168	Crown tissues taken at pakaging	*Fusarium incarnatum*
203	SD17	Crown tissues taken at pakaging	*Fusarium incarnatum*
204	SD170	Crown tissues taken at pakaging	*Fusarium incarnatum*
205	SD171	Crown tissues taken at pakaging	*Fusarium incarnatum*
206	SD172	Crown tissues taken at pakaging	*Fusarium incarnatum*
207	SD173	Crown tissues taken at pakaging	*Fusarium incarnatum*
208	SD174	Crown tissues taken at pakaging	*Fusarium incarnatum*
209	SD178	Crown tissues taken at pakaging	*Fusarium incarnatum*
210	SD179	Crown tissues taken at pakaging	*Fusarium incarnatum*
211	SD180	Crown tissues taken at pakaging	*Fusarium incarnatum*
212	SD182	Crown tissues taken at trimming point	*Fusarium incarnatum*
213	SD183	Crown tissues taken at trimming point	*Fusarium incarnatum*
214	SD184	Crown tissues taken at trimming point	*Fusarium incarnatum*
215	SD185	Crown tissues taken at trimming point	*Fusarium incarnatum*
216	SD186	Crown tissues taken at trimming point	*Fusarium incarnatum*
217	SD188	Crown tissues taken at trimming point	*Fusarium incarnatum*
218	SD189	Crown tissues taken at trimming point	*Fusarium incarnatum*
219	SD19	Crown tissues taken at trimming point	*Fusarium incarnatum*
220	SD190	Crown tissues taken at trimming point	*Fusarium incarnatum*
221	SD191	Crown tissues taken at trimming point	*Fusarium incarnatum*
222	SD197	Crown tissues taken at trimming point	*Fusarium incarnatum*
223	SD203	Crown tissues taken at trimming point	*Fusarium incarnatum*
224	SD206	Crown tissues taken at trimming point	*Fusarium incarnatum*
225	SD208	Crown tissues taken at trimming point	*Fusarium incarnatum*
226	SD209	Crown tissues taken at trimming point	*Fusarium incarnatum*
227	SD21	Crown tissues taken at trimming point	*Fusarium incarnatum*
228	SD212	Crown tissues taken at trimming point	*Fusarium incarnatum*
229	SD213	Crown tissues taken at trimming point	*Fusarium incarnatum*
230	SD218	Crown tissues taken at trimming point	*Fusarium incarnatum*
231	SD219	Crown tissues taken at trimming point	*Fusarium incarnatum*
232	SD22	Crown tissues taken at trimming point	*Fusarium incarnatum*
233	SD222	Crown tissues taken at dehanding tank	*Fusarium incarnatum*
234	SD226	Crown tissues taken at dehanding tank	*Fusarium incarnatum*
235	SD228	Crown tissues taken at dehanding tank	*Fusarium incarnatum*
236	SD229	Crown tissues taken at dehanding tank	*Fusarium incarnatum*
237	SD230	Crown tissues taken at dehanding tank	*Fusarium incarnatum*
238	SD231	Crown tissues taken at dehanding tank	*Fusarium incarnatum*
239	SD24	Crown tissues taken at dehanding tank	*Fusarium incarnatum*

N°	Code	Origin	Identification results
240	SD267	Crown tissues taken at dehanding tank	*Fusarium incarnatum*
241	SD268	Crown tissues taken at dehanding tank	*Fusarium incarnatum*
242	SD27	Crown tissues taken at dehanding tank	*Fusarium incarnatum*
243	SD28	Crown tissues taken at dehanding tank	*Fusarium incarnatum*
244	SD29	Crown tissues taken at dehanding tank	*Fusarium incarnatum*
245	SD297	Crown tissues taken at dehanding tank	*Fusarium incarnatum*
246	SD30	Crown tissues taken at dehanding tank	*Fusarium incarnatum*
247	F31	Crown tissues taken after dehanding tank	*Fusarium musae*
248	SD440	Internal crown tissues taken after packaging	*Fusarium musae*
249	SD441	Crown tissues taken at dehanding tank	*Fusarium musae*
250	A9	Symptomatic crown tissues	*Fusarium oxysporum*
251	D221	Crown tissues taken after dehanding tank	*Fusarium oxysporum*
252	D359	Internal crown tissues taken after packaging	*Fusarium oxysporum*
253	D44	Flowers	*Fusarium oxysporum*
254	D447	Internal crown tissues taken after packaging	*Fusarium oxysporum*
255	D448	Crown tissues taken at dehanding tank	*Fusarium oxysporum*
256	D465	Crown tissues taken at dehanding tank	*Fusarium oxysporum*
257	D528	Internal crown tissues taken after packaging	*Fusarium oxysporum*
258	D531	Internal crown tissues taken after packaging	*Fusarium oxysporum*
259	H03	Crown tissues taken at dehanding tank	*Fusarium oxysporum*
260	SD31	Crown tissues taken at dehanding tank	*Fusarium oxysporum*
261	SD357	Crown tissues taken at dehanding tank	*Fusarium oxysporum*
262	SD39	Crown tissues taken at dehanding tank	*Fusarium oxysporum*
263	SD40	Crown tissues taken at dehanding tank	*Fusarium oxysporum*
264	C1-2	Symptomatic crown tissues	*Fusarium proliferatum*
265	C4-3	Symptomatic crown tissues	*Fusarium proliferatum*
266	C4-4	Symptomatic crown tissues	*Fusarium proliferatum*
267	D127	Crown tissues taken at dehanding.	*Fusarium proliferatum*
268	D225	Crown from field	*Fusarium proliferatum*
269	D46	Crown tissues taken after Alum treatment	*Fusarium proliferatum*
270	SD490	Outer layer crown tissues taken after packaging	*Fusarium proliferatum*
271	D491	Crown tissues	*Fusarium proliferatum*
272	D816	Internal crown tissues taken after packaging	*Fusarium proliferatum*
273	SD444	Outer layer crown tissues taken after packaging	*Fusarium proliferatum*
274	SD445	Outer layer crown tissues taken after packaging	*Fusarium proliferatum*
275	SD45	Crown tissues	*Fusarium proliferatum*
276	SD47	Crown tissues	*Fusarium proliferatum*
277	SD485	Crown tissues	*Fusarium proliferatum*
278	SD485	Crown tissues	*Fusarium proliferatum*
279	SD488	Crown tissues	*Fusarium proliferatum*

N°	Code	Origin	Identification results
280	SD494	Internal crown tissues taken after packaging	*Fusarium proliferatum*
281	SD5	Crown tissues	*Fusarium proliferatum*
282	SD515	Internal crown tissues taken after packaging	*Fusarium proliferatum*
283	D152	Crown debris	*F. pseudocircinatum*
284	D53	Crown from field	*F. pseudocircinatum*
285	F33	Crown tissues taken after dehanding tank	*F. pseudocircinatum*
286	SD42	Crown tissues	*F. pseudocircinatum*
287	SD439	Crown tissues	*F. pseudocircinatum*
288	SD527	Internal crown tissues taken after packaging	*F. pseudocircinatum*
289	SD553	Outer layer crown tissues taken after packaging	*F. pseudocircinatum*
290	SD554	Crown tissues	*F. pseudocircinatum*
291	SD563	Internal crown tissues taken after packaging	*F. pseudocircinatum*
292	C2-2	Symptomatic crown tissues	*Fusarium sacchari*
293	C2-4	Symptomatic crown tissues	*Fusarium sacchari*
294	C5-1	Symptomatic crown tissues	*Fusarium sacchari*
295	C5-2	Symptomatic crown tissues	*Fusarium sacchari*
296	D125	Crown from boxes	*Fusarium sacchari*
297	D146	Crown from boxes	*Fusarium sacchari*
298	D164	Crown tissues taken after dehanding tank	*Fusarium sacchari*
299	D176	Crown tissues	*Fusarium sacchari*
300	D220	Crown tissues taken after dehanding tank	*Fusarium sacchari*
301	F25	Crown tissues taken at dehanding.	*Fusarium sacchari*
302	F27	Crown tissues taken at dehanding.	*Fusarium sacchari*
303	SD568	Internal crown tissues taken after packaging	*Fusarium sacchari*
304	SD59	Crown tissues	*Fusarium sacchari*
305	SD590	Internal crown tissues taken after packaging	*Fusarium sacchari*
306	SD591	Crown tissues	*Fusarium sacchari*
307	SD592	Internal crown tissues taken after packaging	*Fusarium sacchari*
308	SD593	Outer layer crown tissues taken after packaging	*Fusarium sacchari*
309	SD594	Outer layer crown tissues taken after packaging	*Fusarium sacchari*
310	SD595	Outer layer crown tissues taken after packaging	*Fusarium sacchari*
311	SD61	Crown tissues taken at packaging	*Fusarium sacchari*
312	SD62	Crown tissues taken at packaging	*Fusarium sacchari*
313	SD63	Crown tissues taken at packaging	*Fusarium sacchari*
314	SD65	Crown tissues taken at packaging	*Fusarium sacchari*
315	SD68	Crown tissues taken at packaging	*Fusarium sacchari*
316	SD69	Crown tissues taken at packaging	*Fusarium sacchari*
317	SD70	Crown tissues taken at packaging	*Fusarium sacchari*
318	SD72	Crown tissues taken at packaging	*Fusarium sacchari*
319	SD815	Internal crown tissues taken after packaging	*Fusarium sacchari*

N°	Code	Origin	Identification results
320	SD818	Crown tissues	*Fusarium sacchari*
321	SD819	Crown tissues	*Fusarium sacchari*
322	SD822	Internal crown tissues taken after packaging	*Fusarium sacchari*
323	SD826	Internal crown tissues taken after packaging	*Fusarium sacchari*
324	SD976	Internal crown tissues taken after packaging	*Fusarium sacchari*
325	SD977	Crown tissues	*Fusarium sacchari*
326	C1-4	Symptomatic crown tissues	*Fusarium solani*
327	D1024	Internal crown tissues taken after packaging	*Fusarium solani*
328	D11	Flowers	*Fusarium solani*
329	D137	Flowers	*Fusarium solani*
330	D187	Crown from boxes	*Fusarium solani*
331	D360	Outer layer crown tissues taken after packaging	*Fusarium solani*
332	D468	Internal crown tissues taken after packaging	*Fusarium solani*
333	D484	Outer layer crown tissues taken after packaging	*Fusarium solani*
334	D52	Flowers	*Fusarium solani*
335	SD538	Internal crown tissues taken after packaging	*Fusarium solani*
336	D56	Flowers	*Fusarium solani*
337	SD978	Crown tissues	*Fusarium solani*
338	SD983	Internal crown tissues taken after packaging	*Fusarium solani*
339	SD984	Outer layer crown tissues taken after packaging	*Fusarium solani*
340	SD987	Outer layer crown tissues taken after packaging	*Fusarium solani*
341	SD989	Crown tissues	*Fusarium solani*
342	SH19	Crown tissues	*Fusarium solani*
343	A04	Symptomatic crown tissues	*Fusarium verticillioides*
344	B01	Symptomatic crown tissues	*Fusarium verticillioides*
345	B06	Symptomatic crown tissues	*Fusarium verticillioides*
346	C1-1	Symptomatic crown tissues	*Fusarium verticillioides*
347	C1-3	Symptomatic crown tissues	*Fusarium verticillioides*
348	C2-3	Symptomatic crown tissues	*Fusarium verticillioides*
349	C3-2	Symptomatic crown tissues	*Fusarium verticillioides*
350	C4-1	Symptomatic crown tissues	*Fusarium verticillioides*
351	D175	Crown tissues taken after dehanding tank	*Fusarium verticillioides*
352	D192	Crown tissues taken after second tank	*Fusarium verticillioides*
353	D464	Internal crown tissues taken after packaging	*Fusarium verticillioides*
354	D49	Crown tissues taken after second tank	*Fusarium verticillioides*
355	SD570	Outer layer crown tissues taken after packaging	*Fusarium verticillioides*
356	D988	Internal crown tissues taken after packaging	*Fusarium verticillioides*
357	E02	Symptomatic crown tissues	*Fusarium verticillioides*
358	E04	Symptomatic crown tissues	*Fusarium verticillioides*
359	E11	Symptomatic crown tissues	*Fusarium verticillioides*

N°	Code	Origin	Identification results
360	H12	Crown from field	*Fusarium verticillioides*
361	H14	Flowers	*Fusarium verticillioides*
362	H15	Crown tissues taken at dehanding.	*Fusarium verticillioides*
363	H16	Crown tissues taken at dehanding.	*Fusarium verticillioides*
364	H17	Crown tissues taken after dehanding tank	*Fusarium verticillioides*
365	H18	Crown tissues taken after dehanding tank	*Fusarium verticillioides*
366	I15	Crown tissues taken after dehanding tank	*Fusarium verticillioides*
367	SD443	Internal crown tissues taken after packaging	*Fusarium verticillioides*
368	SD486	Crown tissues	*Fusarium verticillioides*
369	SH20	Crown tissues	*Fusarium verticillioides*
370	SH21	Crown tissues	*Fusarium verticillioides*
371	SH22	Crown tissues	*Fusarium verticillioides*
372	SH23	Crown tissues	*Fusarium verticillioides*
373	SH24	Crown tissues	*Fusarium verticillioides*
374	SH25	Crown tissues	*Fusarium verticillioides*
375	SH26	Crown tissues	*Fusarium verticillioides*
376	SH41	Crown tissues	*Fusarium verticillioides*
377	SH42	Crown tissues	*Fusarium verticillioides*
378	D75	Crown debris	*L. pseudotheobromae*
379	D76	Crown tissues	*L. pseudotheobromae*
380	D88	Flowers	*L. pseudotheobromae*
381	D89	Crown from field	*L. pseudotheobromae*
382	D90	Crown from field	*L. pseudotheobromae*
383	D91	Crown from field	*L. pseudotheobromae*
384	A12	Symptomatic crown tissues	*Lasiodiplodia theobromae*
385	A13	Symptomatic crown tissues	*Lasiodiplodia theobromae*
386	A05	Symptomatic crown tissues	*Lasiodiplodia theobromae*
387	D1025	Crown tissues	*Lasiodiplodia theobromae*
388	D255	Crown tissues taken after dehanding tank	*Lasiodiplodia theobromae*
389	D440	Internal crown tissues taken after packaging	*Lasiodiplodia theobromae*
390	D461	Crown tissues	*Lasiodiplodia theobromae*
391	D462	Crown tissues	*Lasiodiplodia theobromae*
392	D549	Outer layer crown tissues taken after packaging	*Lasiodiplodia theobromae*
393	D66	Crown from field	*Lasiodiplodia theobromae*
394	D73	Crown from field	*Lasiodiplodia theobromae*
395	D74	Flowers	*Lasiodiplodia theobromae*
396	D77	Crown tissues taken after dehanding tank	*Lasiodiplodia theobromae*
397	D78	Crown tissues	*Lasiodiplodia theobromae*
398	D79	Flowers	*Lasiodiplodia theobromae*
399	D80	Crown tissues	*Lasiodiplodia theobromae*

N°	Code	Origin	Identification results
400	D81	Flowers	*Lasiodiplodia theobromae*
401	D94	Crown tissues taken after Alum treatment	*Lasiodiplodia theobromae*
402	D96	Crown tissues taken at dehanding.	*Lasiodiplodia theobromae*
403	D97	Crown debris	*Lasiodiplodia theobromae*
404	D98	Flowers	*Lasiodiplodia theobromae*
405	D99	Crown tissues taken at dehanding.	*Lasiodiplodia theobromae*
406	H38	Crown tissues taken at dehanding.	*Lasiodiplodia theobromae*
407	A07	Symptomatic crown tissues	*Microdochium* sp.
408	F23	Crown tissues taken at dehanding.	*Microdochium* sp.
409	F28	Crown tissues taken at dehanding.	*Microdochium* sp.
410	D254	Crown from field	*Microsphaeropsis arundinis*
411	D194	Flowers	*Monilinia*
412	D195	Flowers	*Monilinia*
413	D54	Crown tissues	*Monilinia*
414	D100	Crown from boxes	*Nigrospora* sp.
415	D101	Crown tissues taken after second tank	*Nigrospora* sp.
416	D102	Flowers	*Nigrospora* sp.
417	D103	Crown tissues taken at dehanding.	*Nigrospora* sp.
418	D106	Crown from field	*Nigrospora* sp.
419	D107	Crown from field	*Nigrospora* sp.
420	D108	Crown tissues taken after second tank	*Nigrospora* sp.
421	D109	Flowers	*Nigrospora* sp.
422	D110	Flowers	*Nigrospora* sp.
423	D118	Crown from field	*Nigrospora* sp.
424	D119	Flowers	*Nigrospora* sp.
425	D123	Crown from boxes	*Nigrospora* sp.
426	D133	Crown from boxes	*Nigrospora* sp.
427	D136	Crown tissues taken after Alum treatment	*Nigrospora* sp.
428	D138	Crown tissues taken after Alum treatment	*Nigrospora* sp.
429	D201	Crown tissues taken after dehanding tank	*Nigrospora* sp.
430	D237	Crown from field	*Nigrospora* sp.
431	D240	Crown tissues taken after second tank	*Nigrospora* sp.
432	D241	Crown from field	*Nigrospora* sp.
433	D242	Crown from field	*Nigrospora* sp.
434	D243	Crown from field	*Nigrospora* sp.
435	D244	Crown from field	*Nigrospora* sp.
436	D245	Crown from field	*Nigrospora* sp.
437	D246	Crown tissues taken after dehanding tank	*Nigrospora* sp.
438	D247	Crown tissues taken after dehanding tank	*Nigrospora* sp.
439	D248	Crown from field	*Nigrospora* sp.

N°	Code	Origin	Identification results
440	D250	Crown from field	*Nigrospora* sp.
441	D251	Crown from field	*Nigrospora* sp.
442	D260	Crown tissues taken after second tank	*Nigrospora* sp.
443	D537	Crown tissues	*Nigrospora* sp.
444	D550	Crown tissues	*Nigrospora* sp.
445	D553	Internal crown tissues taken after packaging	*Nigrospora* sp.
446	D555	Crown tissues	*Nigrospora* sp.
447	D82	Crown tissues taken after Alum treatment	*Nigrospora* sp.
448	D83	Flowers	*Nigrospora* sp.
449	D84	Crown tissues taken after second tank	*Nigrospora* sp.
450	D85	Crown tissues taken at dehanding.	*Nigrospora* sp.
451	D86	Crown tissues taken at dehanding.	*Nigrospora* sp.
452	D87	Crown tissues	*Nigrospora* sp.
453	D92	Crown tissues taken after second tank	*Nigrospora* sp.
454	D93	Crown tissues taken at dehanding.	*Nigrospora* sp.
455	F14	Crown tissues taken after dehanding tank	*Nigrospora* sp.
456	F35	Crown tissues taken after dehanding tank	*Nigrospora* sp.
457	F37	Crown tissues taken after Alum treatment	*Nigrospora* sp.
458	F45	Crown tissues taken after Alum treatment	*Nigrospora* sp.
459	H39	Crown tissues	*Nigrospora* sp.
460	H40	Crown tissues taken after dehanding tank	*Nigrospora* sp.
461	H41	Crown tissues	*Nigrospora* sp.
462	H42	Crown from field	*Nigrospora* sp.
463	H43	Crown tissues taken at dehanding.	*Nigrospora* sp.
464	H44	Crown tissues	*Nigrospora* sp.
465	H45	Crown tissues	*Nigrospora* sp.
466	H46	Crown tissues taken after dehanding tank	*Nigrospora* sp.
467	H47	Crown tissues taken after dehanding tank	*Nigrospora* sp.
468	H48	Crown from field	*Nigrospora* sp.
469	I10	Flowers	*Nigrospora* sp.
470	I11	Crown from field	*Nigrospora* sp.
471	I01	Flowers	not identified
472	I02	Crown tissues taken after Alum treatment	not identified
473	I03	Crown tissues taken at dehanding.	not identified
474	I04	Crown tissues	not identified
475	I05	Crown tissues taken after second tank	not identified
476	I06	Crown tissues	not identified
477	I07	Crown tissues taken after dehanding tank	not identified
478	I08	Crown from field	not identified
479	I09	Crown tissues taken after dehanding tank	not identified

N°	Code	Origin	Identification results
480	I14	Crown tissues taken after Alum treatment	not identified
481	I16	Flowers	not identified
482	I17	Crown tissues taken after second tank	not identified
483	D131	Crown tissues taken after dehanding tank	*Penicillium* sp.
484	D129	Crown debris	*Pestalotiopsis* sp.
485	D193	Crown debris	*Pestalotiopsis* sp.
486	D223	Crown from field	*Pestalotiopsis* sp.
487	D224	Crown tissues taken after second tank	*Pestalotiopsis* sp.
488	D32	Crown tissues taken after second tank	*Pestalotiopsis* sp.
489	D33	Crown from field	*Pestalotiopsis* sp.
490	D34	Crown tissues taken after Alum treatment	*Pestalotiopsis* sp.
491	D35	Crown tissues taken after dehanding tank	*Pestalotiopsis* sp.
492	D36	Crown tissues	*Pestalotiopsis* sp.
493	F22	Crown tissues taken after Alum treatment	*Pestalotiopsis* sp.
494	D132	Crown from boxes	*Phoma sorghina*
495	D232	Crown from field	*Phoma sorghina*
496	D236	Crown from field	*Phoma sorghina*
497	D235	Crown from field	*Phoma* sp.
498	D262	Crown from field	*Phoma* sp.
499	D463	Crown tissues	*Phoma* sp.
500	D514	Outer layer crown tissues taken after packaging	*Phoma* sp.
501	D571	Crown tissues	*Phoma* sp.
502	D130	Crown debris	*Phoma* sp.
503	D134	Crown tissues taken after second tank	*Phoma* sp.
504	D263	Crown from field	*Phoma* sp.
505	F40	Crown tissues taken after Alum treatment	*Spencermartinsia viticola*
506	D120	Crown tissues taken after dehanding tank	*Sterile mycelium*
507	D256	Crown from field	*Sterile mycelium*
508	SD492	Outer layer crown tissues taken after packaging	*Sterile mycelium*
509	D37	Crown tissues taken after dehanding tank	*Trichoderma* sp.
510	D158	Flowers	*T. contamination*
511	D202	Flowers	*T. contamination*
512	D204	Crown tissues taken after dehanding tank	*T. contamination*
513	D205	Crown tissues taken after dehanding tank	*T. contamination*
514	D266	Crown from field	*T. contamination*
515	D269	Crown tissues taken after dehanding tank	*T. contamination*
516	D270	Crown tissues taken after second tank	*T. contamination*
517	D271	Crown from field	*T. contamination*
518	D26	Crown tissues taken after dehanding tank	*Trichoderma virens*

Therefore we can summarize that, in this chapter, we studied the fungal populations related to crown rot of organic bananas in the Dominican Republic. The fungal species isolated from organic bananas in this study were similar to those isolated from other areas producing bananas around the world (Goos and Tschirsch, 1962; Johanson and Blazquez, 1992; Anthony *et al.*, 2004; Alvindia and Natsuaki, 2008; Lassois *et al.*, 2008; Lassois *et al.*, 2010b; Ewane *et al.*, 2013). *F. incarnatum* and *F. verticillioides* were identified in this study, similarly to other countries, however the Dominican population was characterized by some peculiar taxa, such as *F. sacchari, F. musae, F. dimerum, F. proliferatum, F. pseudocircinatum, Alternaria* spp., *Curvularia* spp., and *Microdochium* sp. which were not previously reported (table 2-10). The genus *Fusarium* was the most frequent genus as it was reported in previous studies (Knight, 1982; Marin *et al.*, 1996). Studies on fungal population related to crown rot on organic bananas are rarer compared to studies on banana from traditional farming. In this study, we confirmed the presence of different etiological agents of crown rot, for example *Alternaria* spp., *C. musae*, *F. incarnatum*, *F. verticillioides*, *L. pseudotheobromae* and *L. theobromae*. They were isolated also in field from banana flowers even before forming the fruits.

In Costa Rica, the most frequent taxa found in diseased samples were *C. musae* and *F. subglutinans* (Umana-Rojas and Garcia, 2011a), with different frequency from what is reported in the present study, and there were some other *Fusarium* species not yet detected in Dominican Republic. In Ghana, *Botryodiplodia theobromae* Pat. (the former name of *L. theobromae*) was the most frequent fungal organism (Ocran *et al.*, 2011) with a higher frequency compared with the present study.

Lasiodiplodia theobromae was one of the most virulent pathogen of banana crown complex detected in Dominican Republic followed by *C. musae*, and *Fusarium* spp. Our results are in agreement with a previous study conducted in Sri Lanka, where *L. theobromae* caused a fast spread of crown rot (Gunasinghe and Karunaratne, 2009), differently from what was reported in Windward Island, where *C. musae* was the most virulent species (Finlay and Brown, 1993), and from what was reported in Costa Rica, where *Fusarium* spp. resulted the most virulent isolate (Umana-Rojas and Garcia, 2011b). Other strains isolated from banana crown tissues are considered common saprophytes or postharvest pathogens on other fruits: their role in the crown rot development could be ancillary, by increasing the infection prevalence, and should be investigated further.

Table 2-10. Fungal species isolated from crown rot in Dominican Republic from different production areas.

Countries	Dominican Republic	Honduras	Central and South America		Windward Islands (WI)									Jamaica	Sir Lanka	Nigeria	Somalia, WL, Guatemala	Philippines
References	Present study	15	1	4	16	7	6	12	11	9	8	13	3	10	14	5	2	17
C. musae	7%	3%	F	0-10%	23-33%	36%	24%	26-44%	I	X	I	I	I	11%	X	27%	38%	P
F. incarnatum	29%	80%	MF	4-50%		27%	18%	7-23%		X	I	I	I	F		3%	X	
F. verticillioides	7%	14%	X	0-28%		6%	3%	6-21%	I	X		I	I	X	X	10%	X	P
F. sporotrichoides																	20%	
F. oxysporum	3%						3%					I	I	X		4%		
F. solani	3%						2%									6%		
Lasiodiplodia spp.	6%	12%	R			2%	2%	3-9%		X		I	I	3%	X	26%		P
Musicillium theobromae		81%	F		5-7%	8%	3%	4-18%				I	I	13%		2%	2%	
Gliocladium roseum				0-30%	5%		2%	0-10%										
Nigrospora sphaerica	11%		R			<1%	<1%	24-26%				I	I	1%				
Acremonium sp.	R	93%		0-8%			2%	0-10%	I					3%			4%	
Penicillium sp.	11%			0-33%			<1%											
Alternaria sp.	6%																	
Curvularia sp.	1%																	
F. sacchari	7%																	
F. dimerum	1%																	
F. musae	1%																	
F. proliferatum	4%																	
F. pseudocircinatum	2%																	
Microdochium sp.	R																	
Pestalotiopsis sp.	R																	
Thielaviopsis paradoxa																		P

Percent values correspond to isolation frequencies when given by Lassois and Colleagues (2010b) except in Dominican Rep. by the author. X: indicates that the pathogen was identified on the crown by Lassois and Colleagues (2010b), but without providing any isolation frequency data. F: frequently isolated; MF, most frequently isolated; R: rarely isolated. I: indicate that Lassois and Colleagues (2010b) evaluated fungal pathogenicity without information about isolation frequencies. Information about pathogenicity is shown when given by Lassois and Colleagues (2010b) and in Dominican Rep. by the author. = Highly pathogenic; = medium pathogenicity; = slightly or nonpathogenic.

The references used in this table are as follows: 1- (Goos and Tschirsch, 1962). 2- (Meredith, 1962). 3- (Greene and Goos, 1963). 4- (Lukezic *et al.*, 1967). 5- (Mulvena *et al.*, 1969). 6- (Stover, 1972). 7- (Griffee, 1976). 8- (Knight, 1982). 9- (Eckert and Ogawa, 1985). 10- (Reyes *et al.*, 1998). 11- (Krauss and Johanson, 2000). 12- (Joas and Malisart, 2001). 13- (Khan *et al.*, 2001). 14- (Anthony *et al.*, 2004). 15- (Lassois *et al.*, 2008). 16- (Thompson, 2010). 17- (Alvindia, 2013).

3 Chapter Three : Pathogenicity of etiological agents of crown rot disease on organic banana in Dominican Republic.

3.1 **Introduction**

Different fungal pathogens are involved in crown rot disease varying according to farming area. In Dominican Republic, five organic farms were selected, from which were isolated fungi, representative of different fungal taxa, associated with crown rot disease (described in chapter 2). In order to assess the pathogenicity of individual fungal species associated with crown rot tissues and to understand the role and importance of different species we carried out the pathogenicity trials to confirm "Koch's postulates". In case of such a complex disease as crown rot, the selection of the method used to perform the experimental inoculation is critical, to select optimal conditions for each fungus involved. Therefore, these differences must be taken into account when designing the different experiments. In literature, four common methods of experimental inoculation were used in pathogenicity tests: 1) Producing wound on the skin surface of the banana fruits and inoculation of fungal strains with mycelium-agar plugs (Alvindia *et al.*, 2002); 2) Producing wound using cork-borer into the crown tissue and inoculation of fungal strains with mycelium-agar plugs , which were then covered with parafilm (Griffee, 1976; Adjei, 2010); 3) Spraying conidial suspensions of fungal strains on freshly trimmed crowns (Indrakeerthi and Adikaram, 2011); and 4) Placing filter paper discs soaked in conidial suspension on the surface of freshly trimmed crowns (Marin *et al.*, 1996; Ewane *et al.*, 2013). In this work, we selected two methods to test the pathogenicity of representative fungal strains.

3.2 **Materials and methods**

3.2.1 Preparation of fungal isolates

The inoculum of different fungal isolates was prepared by inoculating four Petri dishes containing PDA medium with a loop from single-spore culture stored on PDA slant at 4°C. The plates were then incubated at 24°C for 6-7 days. All isolates were used in different experiments as ready to use isolates.

3.2.2 Pathogenicity test

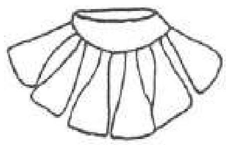
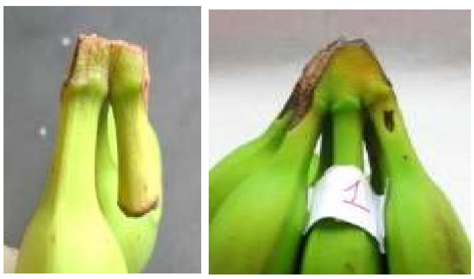
The experiments verifying Koch's postulates were carried out in order to determine the pathogenicity of different fungal strains involved in crown rot disease. From nine identified taxa, we selected 29 representative strains and five different mixtures of various isolates (table 3-1). Out of four common methods of experimental inoculation, two methods were used in our work: 1) wounding the crown tissue using the cork-borer, and inoculating the mycelium-agar plug and 2) spraying asymptomatic trimmed crowns with propagules suspensions. Symptoms were assessed 10-20 days after inoculation. Disease incidence (DI) was calculated as a number of infected crowns relative to the whole crowns in each banana box, and disease severity was assessed in percent by using a scale index (DSI from 0 to7) described in table 3-2. The fungi were re-isolated from each treated crown.

Table 3-1. Fungal strains used in pathogenicity tests and their isolation origin.

Code	**Origin**	**Fungal species**
D113	Crown tissues taken after dehanding tank	*Alternaria alternata*
B09	Symptomatic crown tissues	*Alternaria tenuissima*
C2-1	Symptomatic crown tissues	*Colletotrichum tropicale*
D128	Crown tissues taken after dehanding tank	*Colletotrichum musae*
C3-1	Symptomatic crown tissues	*Colletotrichum musae*
F41	Crown tissues taken after second tank	*Curvularia lunata*
D67	Crown from field	*Fusarium incarnatum*
F34	Crown tissues taken after dehanding tank	*Fusarium incarnatum*
D41	Crown tissues taken after dehanding tank	*Fusarium incarnatum*
F30	Crown tissues taken at dehanding.	*Fusarium dimerum*
A16	Symptomatic crown tissues	*Fusarium incarnatum*
B11	Symptomatic crown tissues	*Fusarium incarnatum*
C2-2	Symptomatic crown tissues	*Fusarium sacchari*
B01	Symptomatic crown tissues	*Fusarium verticillioides*
D221	Crown tissues taken after dehanding tank	*Fusarium oxysporum*
C4-4	Symptomatic crown tissues	*Fusarium proliferatum*
D187	Crown from boxes	*Fusarium solani*
A13	Symptomatic crown tissues	*Lasiodiplodia theobromae*
D89	Crown from field	*Lasiodiplodia pseudotheobromae*

A07	Symptomatic crown tissues	*Microdochium* sp.
F35	Crown tissues taken after dehanding tank	*Nigrospora* sp.
D100	Crown from boxes	*Nigrospora* sp.
F22	Crown tissues taken after Alum treatment	*Pestalotiopsis* sp.
D134	Crown tissues taken after second tank	*Phoma* sp.
F31	Crown tissues taken after dehanding tank	*Fusarium musae*
D175	Crown tissues taken after dehanding tank	*Fusarium verticillioides*
F17	Crown tissues taken after dehanding tank	*Fusarium incarnatum*
C4-3	Symptomatic crown tissues	*Fusarium proliferatum*
D23	Flowers	*Fusarium incarnatum*
D128+A13+B1		*C. musae* + *L. theobromae* + *F. verticillioides*
B1+D128		*C. musae* + *F. verticillioides*
A13+D128		*C. musae* + *L. theobromae*
A13+B1		*L. theobromae* + *F. verticillioides*
F35+B1		*Nigrospora* sp. + *F. verticillioides*

Table 3-2. Severity index scale of crown rot . Drawings by Alvindia (2004) supplemented with images of present research.

Severity index	External view	Internal view
 0		
 1		
 2		

3.2.2.1 Cork-borer method

We used this method to evaluate the pathogenicity of representative strains in the laboratory of fungal diseases, Defens, unimi (in full), Milano. Five symptomless crowns of green bananas (Cavendish) were used as replicates for each treatment (figure 3-1).

Figure 3-1. Symptomless crown of green bananas used in pathogenicity test.

Crown surface was wiped with 5% sodium hypochlorite after trimming and rinsed with distilled water. A wound 3 mm deep was created by cork-borer ($5mm^2$) on the surface of banana crowns (figure 3-2).

Figure 3-2. Wound created by a cork-borer (insert) on the banana crown surface filled with mycelium-agar inoculum.

For each isolate, five-mm-diameter mycelium-agar plug was removed from the edge of 7-day-old colony (figure 3-3) and placed upside-down into the crown wound created. Controls were set using sterile agar plugs and then each banana crown was covered with parafilm. After inoculation, the bananas were packaged and stored at 13°C for 10 days. The disease incidence was assessed. Crown rot index scale of 0 - 7 was used to determine the disease severity by measuring the depth of the rot at the inoculated point after cutting the crown longitudinally (figure 3-4) (Alvindia *et al.*, 2004). Re-isolation of inoculated fungi was carried out to confirm the Koch's postulates from all infected crowns analyzed. The data were analyzed using One-Way ANOVA model using Minitab program 17 (Minitab, 2010), followed by a Tukey *post-hoc* test for multiple comparison (P = 0.05).

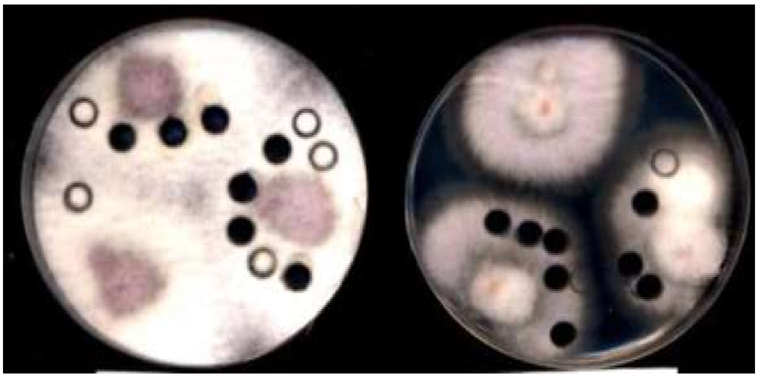


Figure 3-3. The five-millimeter-diameter agar plug taken from 7 day-old culture.

Figure 3-4. Assessment of rot depth in crown after cutting longitudinally from the inoculated point.

3.2.2.2 Spraying conidial suspensions method

Simulating the natural infection of crown rot pathogens was the purpose, why spraying the conidial suspension was used for the pathogenicity test . Freshly harvested green banana (Musa AAA, Cavendish) were inoculated directly after trimming crown parts at the packinghouse in Dominican Republic. Following the normal handling process, hands were selected randomly at the end of the selection line, after the second washing tank. Three PDA plates for each strain were incubated for a minimum three days at 24°C. The inoculum was prepared by collecting the mycelium masses using sterile spatula dispersed in 50 ml of clean potable water (figure 3-5). The samples were homogenized with a hand blender for about ten seconds. The blenter was disinfected between uses by immersion in sodium hypochlorite 10% for 20-30 seconds and rinsed in water (figure 3-6). The suspension was filtered through a double layer of sterile gauze and using light microscope, propagules of fungi were counted using haemocytometer slide, then adjusted to 10^6 conidia /mL^{-1} (figure 3-7; table 3-3). The inoculum was sprayed using a hand sprayer, which was disinfected between between uses with sodium hypochlorite and and rinsed at least three times with clean water (figures 3-8, 3-9). More than 1150 hands of bananas were used and packaged in 54 boxes containing a plastic bag closed with a rubber band, according to normal packaging protocols (figure 3-10). The boxes were overseas transported at 13°C, without passing the commercial ripening phase, delivered to the laboratory in Milan within 15-20 days from the inoculation in order to assess the disease incidence and disease severity as described above. Each banana hand was marked with a number code and re-isolation of inoculated fungi was carried out from all treated crowns, and especially symptomatic ones.

Figure 3-5. Preparation of the inoculum by collecting fresh mycelium in clean potable water.

Figure 3-6. Homogenization of different mycelium suspensions using blender and then filtration using four layer of gauze, then the number of propagules was counted under the microscope.

Figure 3-7. After the suspensions adjusted to 10^6 conidia /mL^{-1} then were become ready for use we and then ready for use in nebulizers -one for each strains-.

Figure 3-8. Collecting green bananas directly after the second washing tank, each group of about 20 hands were redy to packged in one box with one treatment.

Figure 3-9. All tools used were disinfected with sodium hypochlorite solution and then rinsed in water.

Figure 3-10. Bananas were packaged in boxes previously marked and coded then following normal way for shipping.

Table 3-3. The strains used in pathogenicity test and number of propagules present in conidial suspensions used as inoculum.

Code	Strains	UFC*10^4/mL	Code	Strains	UFC*10^4/mL
A13	*Lasiodiplodia theobromae*	**36**	**D41**	*Fusarium incarnatum*	**246**
D89	*L. pseudotheobromae*	**27**	**C4-4**	*Fusarium proliferatum*	**384**
C3-1	*Colletotrichum musae*	**99**	**C2-1**	*Colletotrichum tropicale*	**447**
D128	*Colletotrichum musae*	**78**	**A16**	*Fusarium incarnatum*	**414**
A07	*Microdochium* sp.	**240**	**D221**	*Fusarium oxysporum*	**198**
C2-2	*Fusarium sacchari*	**690**	**F41**	*Curvularia lunata*	**60**
B11	*Fusarium incarnatum*	**108**	**D187**	*Fusarium solani*	**135**
B01	*Fusarium verticillioides*	**249**	**D113**	*Alternaria alternata*	**15**
F34	*Fusarium incarnatum*	**15**	**D134**	*Phoma* sp.	**30**
F30	*Fusarium dimerum*	**165**	**F22**	*Pestalotiopsis* sp.	**36**
D100	*Nigrospora* sp.	**63**	**F35**	*Nigrospora* sp.	**63**
D67	*Fusarium incarnatum*	**36**	**MIX**	D128 + A13 + B1	**78**
Control		**0**			

3.2.2.3 Comparison between the two inoculation methods

Comparisons between the two inoculation methods was done on bananas treated with *Fusarium* isolates as source of inoculum. Six boxes of green bananas were used for the trial in the laboratory in Milano. Different variable conditions were fixed by using the same preparation and incubation conditions, in addition to the two inoculation methods, dividing our samples into two groups randomly and inoculating one group using cork-borer technique and the other one using spraying conidial suspension after adjusted to 10^6 conidia /mL^{-1} (table 3-4). All hands were packaged and stored at 13°C in the incubator for 10 days. The disease incidence and disease severity were assessed as previously described. Finally, re-isolation of inoculated fungi was carried out from all treated crowns to confirm the Koch's postulates. The data were analyzed using t-test model for each pathogen alone, with Minitab program (Minitab, 2010).

Table 3-4. Number of propagules present in different conidial suspensions used as inoculum.

Code	Strains	UFC*10^4/mL
F31	*Fusarium musae*	**615**
D175	*Fusarium verticillioides*	**981**
B11	*Fusarium incarnatum*	**240**
D23	*Fusarium incarnatum*	**111**
A16	*Fusarium incarnatum*	**39**
F17	*Fusarium incarnatum*	**213**
F30	*Fusarium dimerum*	**342**
C4-3	*Fusarium proliferatum*	**417**
C2-2	*Fusarium sacchari*	**519**
A07	*Microdochium* sp.	**552**
Control	Clean water	**0**

3.2.3 Additional trials

3.2.3.1 Role of Alum treatment and Isolation from different depths within crown tissues

During the pathogenicity test using conidial suspension inoculation method that we did in Dominican Republic, 12 boxes of banana were used in order to verify the localization of each etiological agent inside crown tissues. Four boxes of banana hands were directly packaged after the second washing bath without any additional treatment of the crown. Other four boxes of fruits were packaged after the alum treatment - as normally adopted in packing stations. Finally, four boxes were prepared after treatment of the crowns 5 g/L of sodium bicarbonate in water, as it was classified as "generally recognized as safe" (GRAS) by the U.S. Food and Drug Administration. Also it was exempt from residue tolerances on all agricultural commodities (Palou *et al.*, 2001). Marloth (1930) believed that the sodium bicarbonate ion as such is toxic to the fungi because it contributes to a fungitoxic pH of about 8.4. Consequently, the hydroxyl ion concentration in a solution is high enough to reach pH 10, making the solution toxic (Marloth, 1930; Palou *et al.*, 2001; Alvindia *et al.*, 2004). The boxes were overseas transported at 13°C, without passing the commercial ripening phase, delivered to the laboratory in Milan within 15-20 days from the inoculation in order to assess the disease incidence and disease severity as described in chapter 3.

Isolation were done from each crown as described in chapter 2, the crown tissue was cut at different depth after removing the outer layer, as shown in figure 2-3. 15 pieces from each layer were taken aseptically, and placed into Petri dishes, 9 cm in diameter, containing PDA medium. The plates were incubated at 23-25°C for a period of 5/7 days. The plates were periodically observed using the optical microscope in order to identify and count the different microbial forms as described in chapter 2.

3.2.3.2 Verifying the exchange of water between crown tissue and the washing water in different tanks

Latex comes out naturally from cutted banana tissues and this is the reason of different washing after dehanding as well as after crown trimming. Aim of this trial is to give a preliminary view about the exchange of water between trimmed crown tissue and the washing water in different tanks. A methylene blue solution has been used in concentration of 0.2 g/L, to add the dark blue color in water used in washing tanks. Then bananas hands were dipped in this tanks following normal processes. After (20-30 min.) then the crowns were sliced at 1 mm each slice from outer layer till the end of visible colored tissues (figure 3-11). To evaluate the depth reached by the stain.

Figure 3-11. Bananas were laid in tanks was filled with colored water.

3.3 **Results and discussion**

3.3.1 Cork-borer inoculation method

The pathogenicity tests using this technique allowed us to reproduce the crown rot symptoms on crown tissues after 10 days of incubation at 13°C (figure 3-12).

Figure 3-12. Screening and recording of symptoms of crown rot disease on bananas.

No variance in disease incidence was observed among the strains used, but disease severity varied and clearly showed the importance of *Lasiodiplodia* spp. and *C. musae* as the most virulent species, followed by different *Fusarium* spp., specifically: *F. sacchari, F. verticillioides*, *F. incarnatum* and *F. dimerum* (table 3-5). *Fusarium incarnatum,* which is considered the main pathogen in many countries, showed strain-specific variability to cause the infection and produce symptoms, and its severity ranged between 3-5 grades as a results of the normal strain variability. This variability were not connected to the origin of strains (table 2-9), as two strains of the same origin (strain D41 and F34) had different disease severity. *F. sacchari* and *F. verticillioides* were more virulent than *F. incarnatum*, but correlated with the total frequency of different species isolated from crown tissues (figure 2-11). This suggests that *F. incarnatum* might have more significant role in crown rot disease in Dominican Republic. In case of *Lasiodiplodia* there were no significant differences between *L. theobromae* and *L. pseudotheobromae*. The same situation was observed in case of *C. musae* with no significant differences between strains. Other strains showed light crown rot symptoms with no significant differences in terms of disease incidence but they were minor in severity as well as total frequency. Re-isolation was carried out from all infected crowns, and the Koch's postulates were confirmed by re-isolating the same strains formerly used for the inoculation. Rarely, some other fungi developed after re-isolation, belonging to different genera like fusarium. Furthermore, based on the results obtained it can be deduced that, we had no differences in incidence because we used green banana that arrived after more than 20 days of harvest time in wich the banana still green but it has already progressed in terms of maturity.

Table 3-5. Disease severity index (DSI) of representative strains, in pathogenicity test using cork-borer technique.

Code	strain	Disease severity	Statistical report
A13	*Lasiodiplodia theobromae*	**7**	a
C3-1	*Colletotrichum musae*	**7**	a b
D89	*Lasiodiplodia pseudotheobromae*	**7**	a b
D128	*Colletotrichum musae*	**6**	a b c
A07	*Microdochium* sp.	**6**	a b c d
C2-2	*Fusarium sacchari*	**5**	a b c d e
B11	*Fusarium incarnatum*	**5**	a b c d e f
B01	*Fusarium verticillioides*	**4**	a b c d e f g
F34	*Fusarium incarnatum*	**4**	b c d e f g h
D67	*Fusarium incarnatum*	**4**	c d e f g h
D100	*Nigrospora* sp.	**4**	c d e f g h
F30	*Fusarium dimerum*	**4**	c d e f g h i
A16	*Fusarium incarnatum*	**3**	d e f g h i
C2-1	*Colletotrichum tropicale*	**3**	d e f g h i
C4-4	*Fusarium proliferatum*	**3**	d e f g h i
D41	*Fusarium incarnatum*	**3**	d e f g h i
D187	*Fusarium solani*	**3**	e f g h i
D221	*Fusarium oxysporum*	**3**	e f g h i
F41	*Curvularia lunata*	**3**	e f g h i
D113	*Alternaria alternata*	**2**	f g h i
D134	*Phoma* sp.	**2**	g h i
F22	*Pestalotiopsis* sp.	**2**	g h i
F35	*Nigrospora* sp.	**1**	h i
B09	*Alternaria tenuissima*	**1**	i
	Control	**1**	i

3.3.2 Conidial suspension inoculation method

The results obtained showed that the two *C. musae* strains were the most virulent among different species (100% DI and 6-7 DSI), followed by *F. sacchari* (100% DI and 4 DSI), *L. theobromae* and *C. tropicale* strain C2-1 (85% DI and 4 DSI), followed by *L. pseudotheobromae* and *F. verticillioides* (80% DI and 3 DSI). These were the most important species associated with crown rot disease based on the results of the pathogenicity test using conidial suspensions as inoculum (figure 3-13). Surprisingly, *F. incarnatum* reached values ranging between 35-70% DI and 1-4 DSI even though it was the most frequently-isolated pathogen. Which give it special importance as etiological agent of crown rot disease in organic bananas in Dominican Rep., in particular it was reported in various banana-growing areas as one of the main pathogen of this disease (table 2-10).

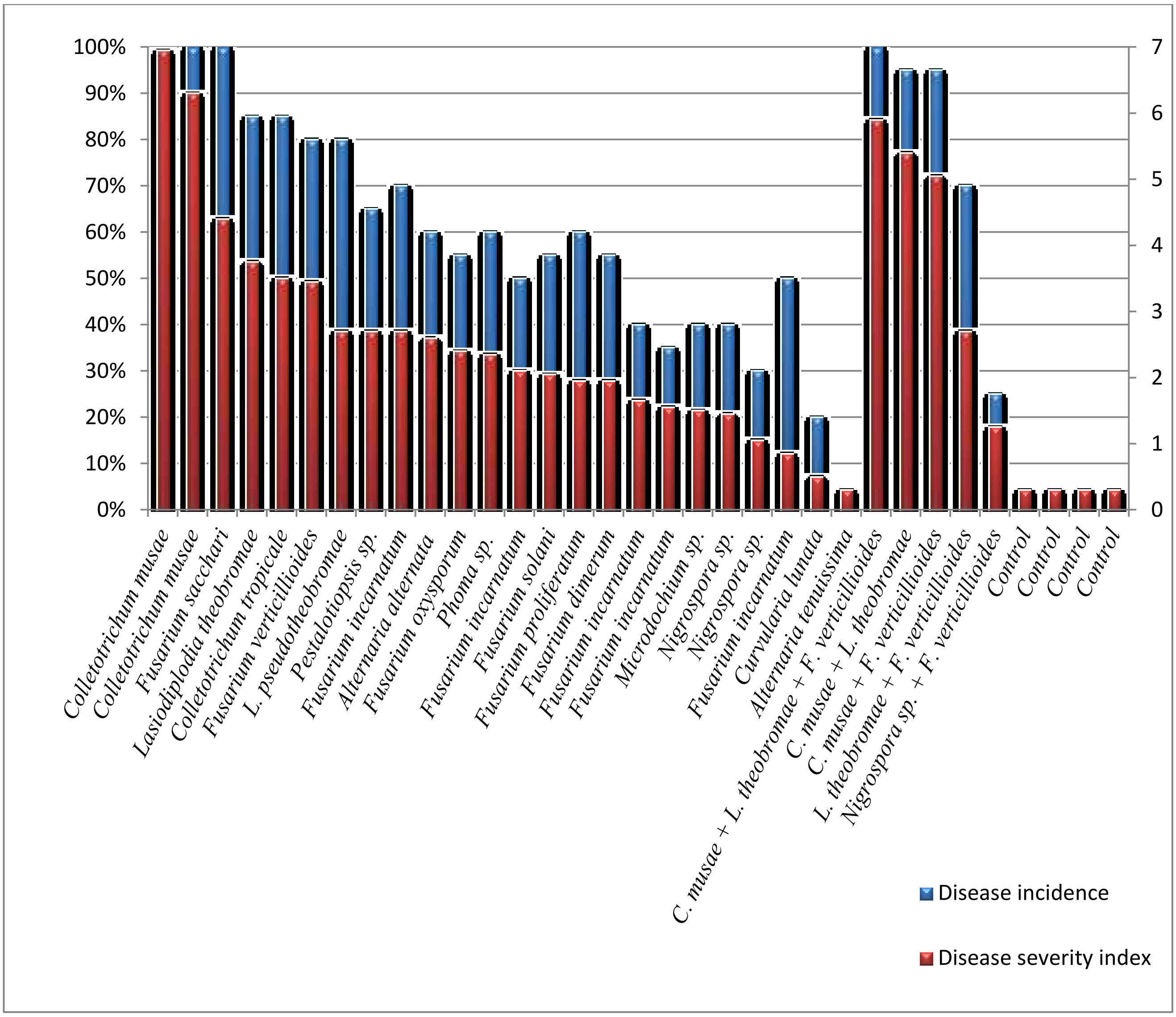


Figure 3-13. Disease incidence and disease severity index of representative strains using conidial suspensions as inoculum.

The remaining strains had low pathogenicity, and their role could be ancillary in the crown rot development. Some of these species, such as *Curvularia* sp., *Alternaria* sp. and *Nigrospora* sp. are considered saprophytic, but in such a complexes disease their role might be in facilitating the infection and development of the symptoms.

Apart from assessing the pathogenicity of individual strains, some strains were used in mix of conidia. These mixed infections generally showed similar results to those obtained using the same individually strain, but in some cases like when strain of *Nigrospora* sp. with *F. verticillioides* the values of DI and DSI were lower than those recorded using each pathogen alone, even though in many cases the results were not statistically significant. The mixture of *C. musae* with *F. verticillioides* or with *L. theobromae* and *F. verticillioides* resulted in lower infections then *C.*

musae alone, but higher than *L. theobromae* and *F. verticillioides*. Finally, re-isolation was carried out from all infected crowns and it confirmed the presence of the inoculated isolates.

3.3.3 Comparison between the two inoculation methods

Using proper inoculation method to evaluate the pathogenicity in case of complex diseases is critical, therefore we compared the two inoculation methods. There were significant differences between the two methods in the case of certain strains, for example: *F. incarnatum*-A16, *Microdochium* sp., *F. incarnatum* -F17, and *F. musae*. no differences were observed for other strains, like *F. verticillioides*, *F. incarnatum*-B11, *F. dimerum*, and *F. proliferatum* (table 3-6).

Table 3-6. Differences between using the two inoculation methods, for both, external and internal symptoms based on disease severity index (DSI).

		External examination	**Internal examination**
Code	**Strains**	***P*-value**	***P*-value**
A16	*Fusarium incarnatum*	0.03398	0.04077
A07	*Microdochium* sp.	0.03692	0.04033
F17	*Fusarium incarnatum*	0.04077	0.07468
F31	*Fusarium musae*	0.05758	0.05339
D175	*Fusarium verticillioides*	0.1038	0.2281
D23	*Fusarium incarnatum*	0.1038	0.05339
B11	*Fusarium incarnatum*	0.1047	0.2544
F30	*Fusarium dimerum*	0.3597	1
C2-2	*Fusarium sacchari*	0.3608	0.07468
C4-3	*Fusarium proliferatum*	0.3874	0.3324
Control	Water	0.113	0.06598

Noting the differences between using the outcome of scale based on both external and internal symptoms in case of using the cork-borer methods as in figure 3-14. It is clearly appears that the external appearance gives the indication of the severity degree less than those we get by the internal examination. It is the same results that we get by controlling the differences in case of using the spraying conidial suspensions technique (figure 3-15).

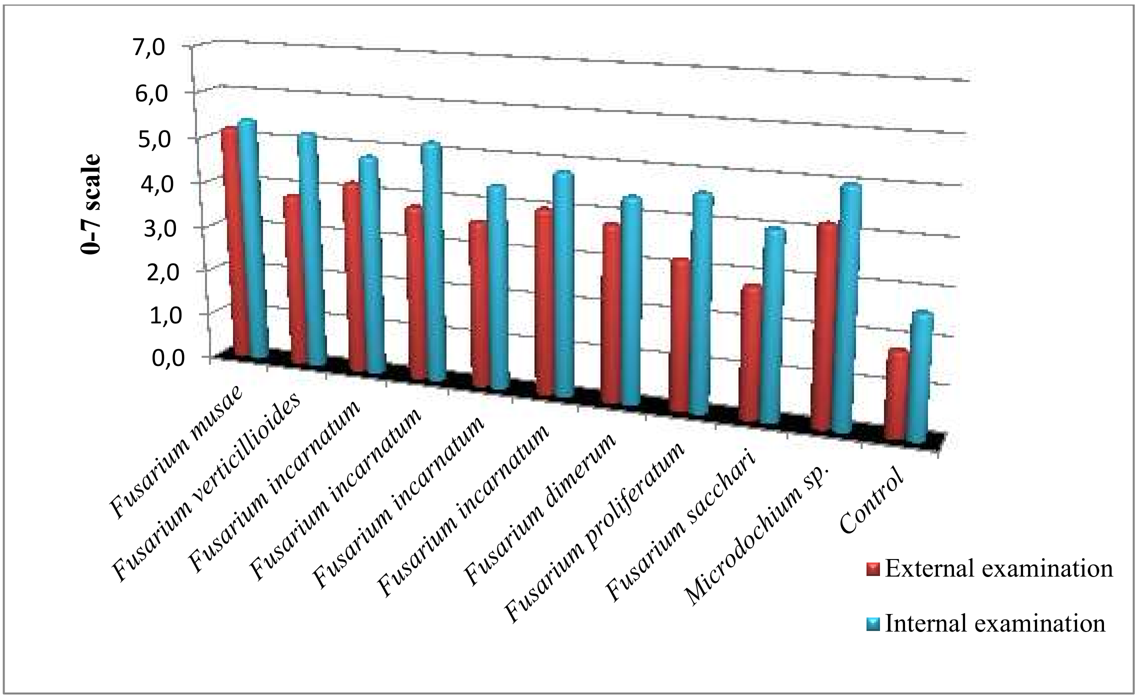


Figure 3-14. Differences between the internal and external examination outcome, in case of applying the cork-borer methods.

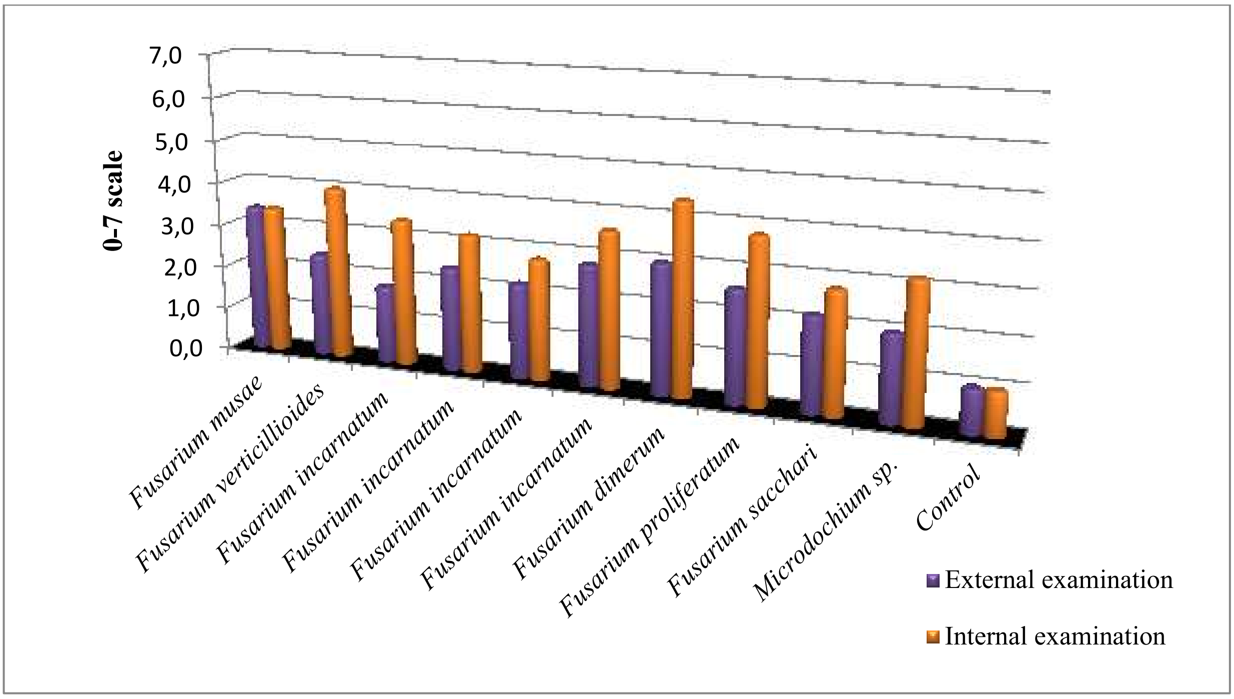


Figure 3-15. Differences between the internal and external examination outcome, in case of applying the spraying conidial suspensions technique.

The comparison of the two methods highlighted consistent overestimate of DSI using the the cork-borer method in comparison with conidial suspensions method simulating the natural infection (figures 3-16 and 3-17). The same result was obtained using external or internal examination.

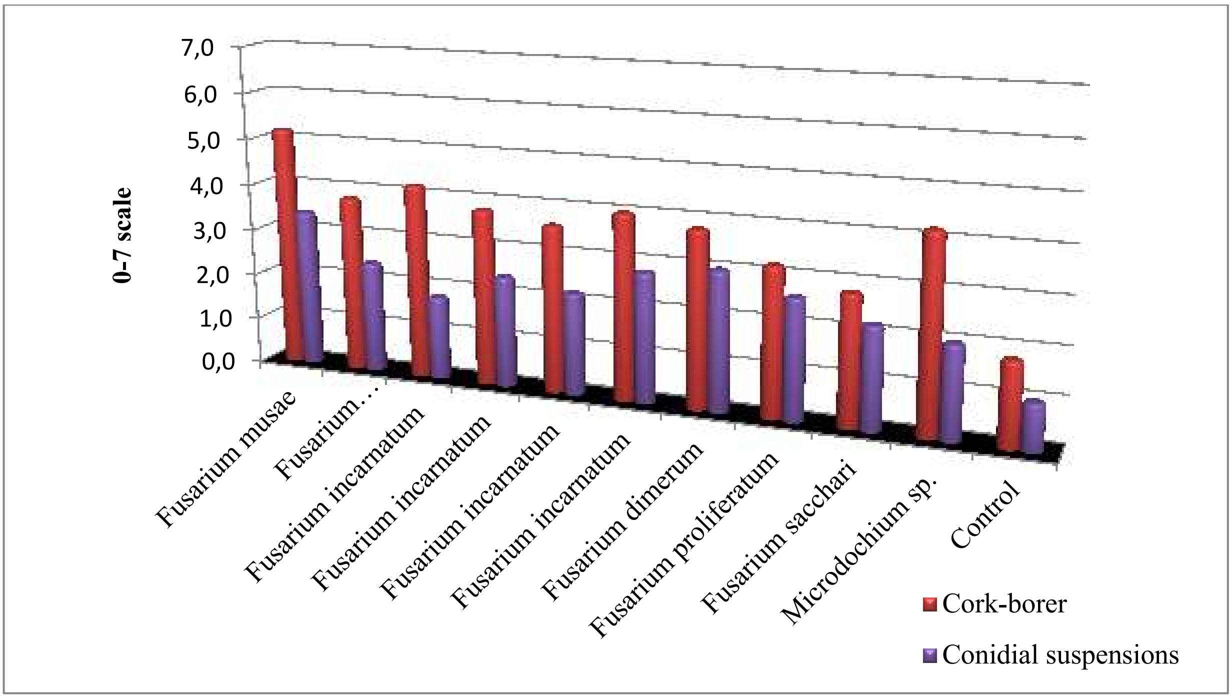


Figure 3-16. Differences in the disease severity index using two inoculation methods; conidial suspensions and cork-borer, after the external examination.

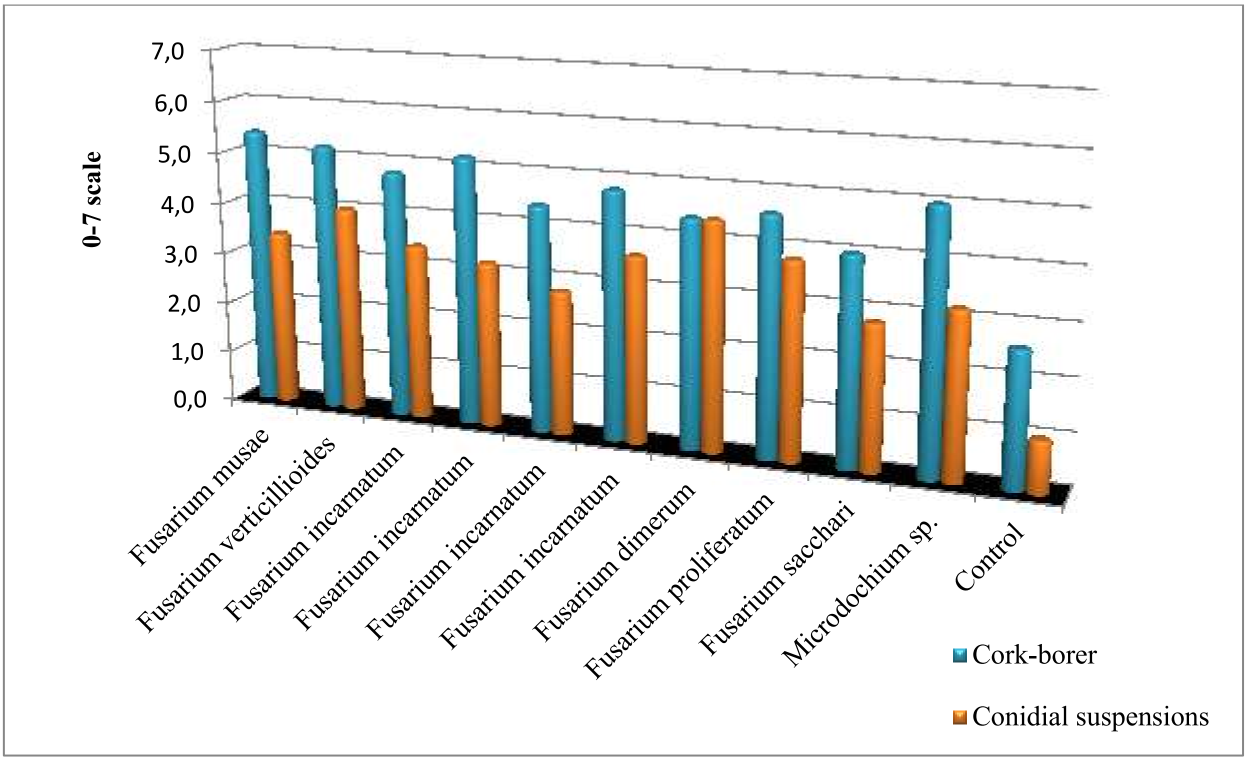


Figure 3-17. Differences in the disease severity index using two inoculation methods; conidial suspensions and cork-borer, after the internal examination.

Finally, by looking to the overview outcome in this comparison presented in table 3-7, and compare it with the previous experiment we did in Dominican Republic using spraying conidial suspensions method, it showed some confusing results. In case of *F. sacchari* that clearly showed formerly virulence activity (100% DI and 4 DSI), in this comparison reached less than 3 DSI, and the other *Fusarium* strains like; *F. incarnatum, F. musae* and *F. verticillioides*, reached the same level or even more than 3 DSI especially all *F. incarnatum* strains. It seems that when we use green bananas after more than 12 days of harvesting it resulted no differences in means of disease incidence and a percentage of rot symptoms appears whatever which inoculum was used.

Table 3-7. the average of the differences results as a total number comparing the two different inoculation methods; cork-borer and spraying conidial suspensions.

Code	Strains	Cork-borer	Conidial suspensions
A16	*Fusarium incarnatum*	5.3	3.4
A07	*Microdochium* sp.	4.5	3.2
F17	*Fusarium incarnatum*	4.5	2.6
F31	*Fusarium musae*	4.5	2.8
D175	*Fusarium verticillioides*	4	2.5
D23	*Fusarium incarnatum*	4.4	3.2
B11	*Fusarium incarnatum*	4.1	3.7
F30	*Fusarium dimerum*	3.9	3.2
C2-2	*Fusarium sacchari*	3.4	2.5
C4-3	*Fusarium proliferatum*	4.6	2.6
	Control	2.2	1

3.3.4 Role of Alum treatment and isolation from different depths within crown tissues

The results obtained showed significant differences between different treatments. In contrast to the previous results presented by Alvindia *et al.* (2004) the sodium bicarbonate enhanced the infection and showed highest disease incidence 81% and 4 degree on severity scale. In contrast and unexpectedly, we had no disease in all boxes packaged directly without protective treatment (table 3-8). Despite the occurrence of pathogenic fungi in untreated tissues after isolation they did not show any symptoms of crown rot disease compared with other treatment.

Table 3-8. Disease incidence (DI) and disease severity index (DSI) of different treatment used.

Treatment	Disease incidence	Disease severity
Sodium bicarbonate	81%	4
Alum	23%	1
Without treatment	0%	0

Considering the isolation, our results showed that, strains of *Colletotrichum* were mainly located inside crown tissues; on the contrary strains of *Lasiodiplodia* that located in the outer surface, while the *Fusarium* strains were isolated from both tissues (figure 3-18). This is particularly evident by comparing the frequenc of fungi isolated from internal (figure 3-19) and external (figure 3-20) crown tissues.

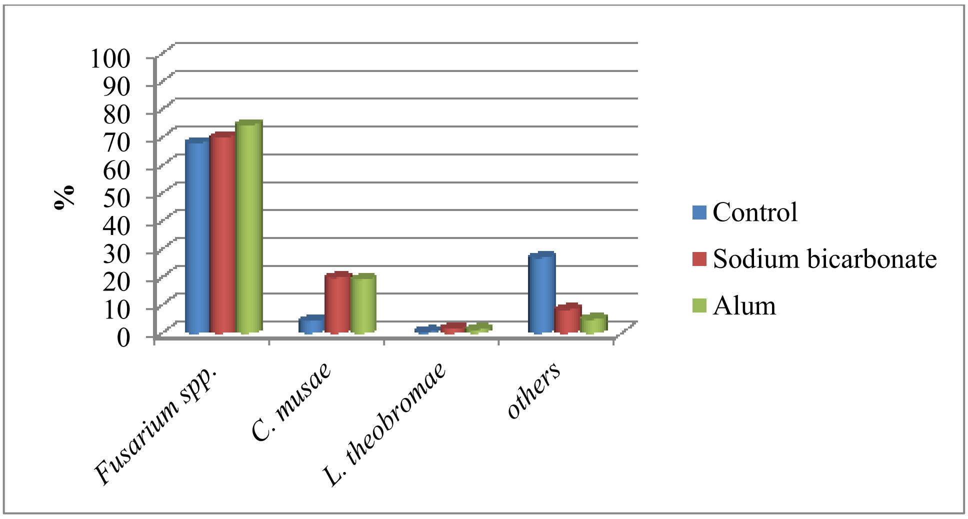


Figure 3-18. The frequency of colonies belonging to important fungal genera associated with crown tissues compared with different treatments.

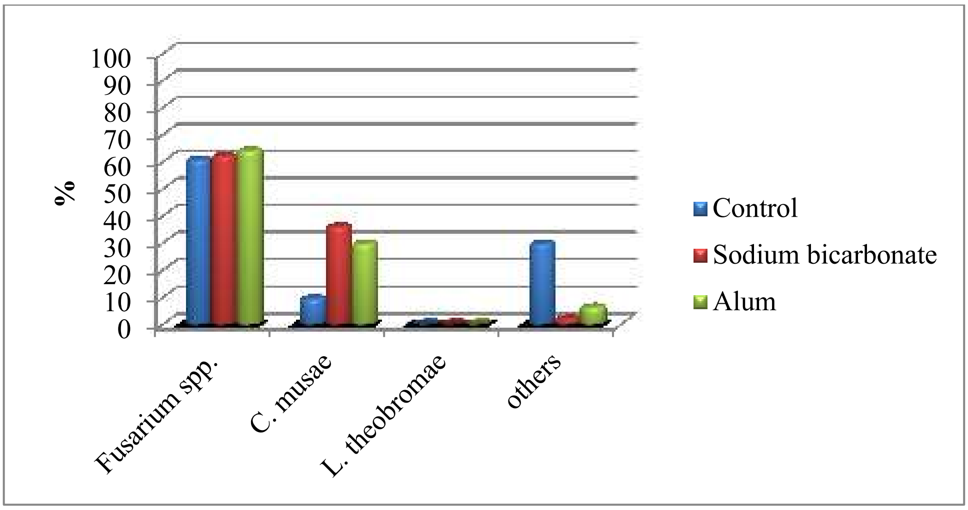


Figure 3-19. The frequency of colonies belonging to important fungal genera associated with internal crown tissues compared with different treatments.

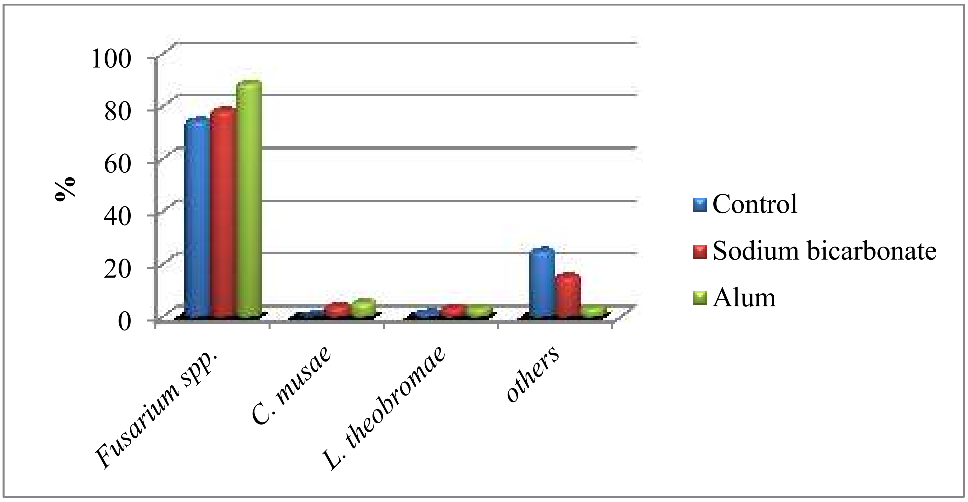


Figure 3-20. The frequency of colonies belonging to important fungal genera associated with external crown tissues compared with different treatments.

3.3.5 Verifying the exchange of water between crown tissue and the washing water in different tanks

The results showed the presence of colored water moved through the internal crown tissues but it is very limited in terms of distance as it did not exceed 1-2 mm toward the internal parts (figure 3-21). This preliminary result is needs more investigation in order to understand the nature of this movement and its relationship with different endophytic fungi.

Figure 3-21. Limited movement of colored water through the internal crown tissues.

4 Chapter Four : Source and spread of fungal pathogens causing crown rot disease in organic bananas.

4.1 Introduction

As formerly reported in second chapter of this work that, crown rot is a complex fungal disease, causing a great negative impact on organic fruit quality as well as the main postharvest disease of bananas (Alvindia, 2013). By studying the exact situation of crown rot, it was reported in previous literature publications that the infection mainly occurs at harvest time, but the symptoms appear after overseas transportation. As well as bananas were harvested while still green and many packaging processes are carried out before coming on the market. These information were challenging us to understand this problem and define measures to control such disease. Then, firstly we recognized the etiological pathogens involved as reported in second chapter, and then, confirming Koch's postulates by pathogenicity test reported in third chapter. It is important as well to determine the infection source and spread mechanism. Particularly as the Dominican Republic has emerged as the world's foremost exporter of organic bananas (Raynolds, 2008; FAOSTAT, 2015), we focused on the critical points of crown rot infections along the processing steps in organic farming, and evaluate all possible sources of infection. For example, to assess the quality of water used in the washing operations in packaging stations.

4.2 Materials and methods

4.2.1 Sampling and isolation

In June 2013, samples were collected as symptomless hands of banana (*Musa* AAA, Cavendish) from five different organic banana plantations and their corresponding packing stations located in Valverde province in Dominican Republic. The laboratory work was done at the University of Milan during 2013. A total of 135 samples were randomly collected covering all post harvest and handling process (figure 1-20) as follow:

- 30 samples including flowers as well as crown parts were collected during deflowering.
- 15 hands were collected from dehanding.
- 15 hands were collected from delatexing tank.
- 15 hands were collected from clustering and trimming the crown area.
- 15 hands were collected from washing tank.
- 15 hands were collected after crown treatment, where they normally use potassium alum dissolved in water "treatment mixture" to treat trimmed crown before bananas packaging (figures 4-1).
- 15 hands were collected from packaged fruits as well.
- 15 hands were collected also from the cutting crown debris.

The crown parts maintained in paper bags for isolation after removing the connected fingers. Flower samples were used directly and the crown's surfaces were disinfected with sodium hypochlorite 5% for 2 min and rinsed in sterile water then the outer layer was removed under sterile condition. From each sample, ten fragments of 5 mm^2 were aseptically collected and placed to dry on sterile filter paper under a sterile air flow then transferred into Petri dishes, 9 cm in diameter, on the surface of PDA^{+++}. The plates were incubated for 6 days at 24°C. The optical microscope was used to count and identify the purified fungal colonies developed from tissues fragments after incubation.

Figure 4-1. Treating freshly trimmed crown of bananas using potassium alum dissolved in water.

4.2.2 Morphological and molecular identification

Based on the characteristics of a colony on PDA: color, shape, size, pigmentation, growth rate, and mycelium type; 270 isolates were grouped and identified morphologically and 85 representative isolates were submitted to the molecular identification. Morphological identification and molecular characterization were carried out following the same methods formerly described in the second chapter of this work.

4.2.3 The occurrence of microorganisms in water used in packinghouse

In parallel with collection of crown samples from different packing stations, we had collected water samples that used to fill the different washing tanks, as well as the water used for the preparation of different treatments (figures 4-2). A total of 16 water samples were collected from different packing stations considering the source of water (well), water present in delatexing tank and washing tanks as well as the treatment mixture. Serial dilutions were used to determine bacteria and fungi propagules counts. Four replicates of Petri dishes contains PDA were used for each dilution. After four days of incubation at 24°C, all plates were controlled and the colony forming units (CFUs) of all mycelial fungi, bacteria and yeast were determined. Based on the characteristics of colonies and the reproductive structures observed under light microscope, all mycelial fungi were identified at genus level (Von Arx, 1974; Barnett and Hunter, 1998; Hanlin, 1998). The percentage of chlorine present in water used were determined using quick colorimetric kit (figure 4-3, 4-4 and 4-5).

Figure 4-2. Collecting samples from different type of water used in banana field or packaging stations.

Figure 4-3. Different kits used to assess the percentage of chlorine present in water.

Figure 4-4. Assessing the percentage of chlorine present in water from different washing tanks.

Figure 4-5. Assessing the percentage of chlorine released by one type of chlorine pellets and granules added in washing tank.

4.3 **Results and discussions**

Out of 1350 plant fragments analyzed, a total of 1495 fungal colonies were obtained, and 270 representative fungal colonies were purified. Fungi were isolated both from field and corresponding packing stations. *Fusarium* was the most frequent genus followed by *Nigrospora* then *Lasiodiplodia* (figure 4-6). This results were agreed with our final results reported in second chapter of this work with some differences in frequency percentage (figure 2-10).

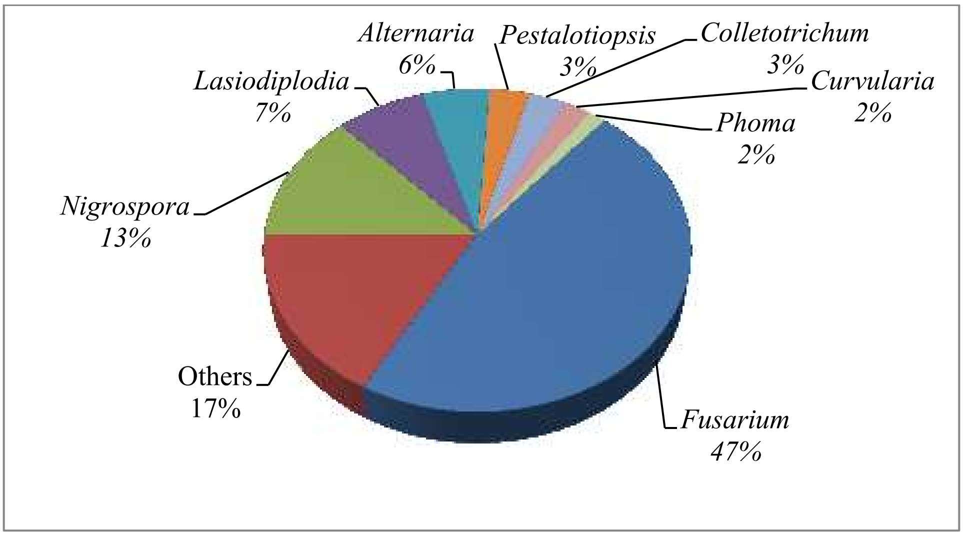


Figure 4-6. The frequency of different fungal genera associated with crown tissues.

Considering each single step of fruits handling the *Fusarium* was the most frequent genus (table 4-1). The fungi were already present in field; from flowers 137 colonies developed from 150 fragments used, and 163 colonies from crown tissues developed from 150 fragments as well, collected during deflowering time.

Table 4-1. Frequency of the most frequent fungal genera isolated from Crown tissues sampled in different packing steps.

Fungal genera	Field		Handling process in packaging stations						
	Flowers	Crown parts	Before the Dehanding	Delatexing tank	Clustering and trimming	Debris	Second washing tank	After Alum treatment	Packaged fruits
Fusarium	72	49	57	54	37	47	56	29	25
Nigrospora	8	18	3	12	3	3	5	6	5
Lasiodiplodia	5	5	0	0	2	2	2	1	3
Others	15	28	41	34	58	48	37	65	67

We confirmed the presence of potentially etiological agents at field in flowers and crown parts, as reported in literature in other countries but they reported that, the infections start at harvest time and flowers were the main inoculum source for pathogens (deBellaire and Mourichon, 1997). Following fruits handling, the presence of fungi developed from 150 fragments used for each step, increased passing through dehanding, delatexing tank, clustering and trimming as well as in debris, till reach the washing point. Then there is a decrease passing from 243 colonies (delatexing tank) to 114 colonies (washing tank). This decrease could be due to the effect of washing water and the addition of chlorine. On the other hand, there is a diffusion of different fungi spores which could infect new crown (Ocran *et al.*, 2011). In some cases the presence of high contamination levels in crown parts after washing tank, was attributed to non-compliance with supposed sanitary measures during preparations and application of potassium alum mixture, as resulted in facility A (figure 4-7, table 4-2).

Table 4-2. The number of colonies obtained through isolation linked to the number of pieces collected from different packing steps.

Source of samples	Steps of packing process	N° of fragments used	N° of colonies	Ratio between n° of colonies and n° of fragments (%)
Field	Flowers	305	280	91.8
Field	Crown parts from field	220	240	109.1[z]
Packing station	Before the Dehanding	120	173	144.2[z]
Packing station	Delatexing tank	140	227	162.1[z]
Packing station	Clustering & trimming	150	184	122.7[z]
Packing station	Debris	150	248	165.3[z]
Packing station	Second washing tank	150	114	76.0
Packing station	After Alum treatment	130	127	97.7
Packing station	Packaged fruits	120	153	127.5[z]

[z] More than one fungal colony was seldom isolated from one crown fragment.

[A]. Water used in delatexing tank. [B]. Water used in washing tank. [C]. Water used in treatment step.

Figure 4-7. Example of assess the quality of water used in various packing steps inside the packaging stations.

The analyses of water used in various packing steps showed the absence significantly low number of fungi in water pumped from wells in all packinghouses (table 4-3). We had the highest contamination in delatexing tank compared with the washing tank, where a sharp drop in the number of fungi (CFU/ml) always shown between both of them. Varied number of yeast was obtained among various steps as well as from different facilities. They were significantly in a high levels in delatexing tank of facility (G) reaching 4170.6 CFU/ml compared with all other facilities except (B). The washing tank in all stations the least in meaning of the total microbial load. But it remains one of the most critical steps in which the spread of the disease occurs because of the proportion of fungal pathogens which are relatively few. In additions the presence of freshly trimmed crown tissues in appropriate conditions for infection. These results obtained in facilities B, G, M, Y and F were compatible with the results obtained in this study from the isolation using crown parts picked from same steps. The fungi found in water samples belong mainly to four genera: *Fusarium* which includes different species known as etiological agents of crown rot disease, *Penicillium*, *Aspergillus* and *Cladosporium*.

Table 4-3. The number of colonies obtained through assessment of the quality of water used in various packing steps.

Farming area and corresponding facility	pickup point	Funghi (CFU/ml)	Yeast (CFU/ml)	Bacteria (CFU/ml)
Billy (B)	Irrigation water	0,4	0	34.000
	source	0	0	8.000
	Delatexing tank	733	5,6	2.568
	Second washing tank	163,2	311,8	126
	Alum	2	0	0
Bogaert (G)	Irrigation water	0,6	0	6000
	source	0	0	3600
	Delatexing tank	272,2	4170,6	6000
	Second washing tank	16,3	16,4	0
	Alum	94	183	0
Mota (M)	Irrigation water	1,1	11,6	82000
	source	3	0	147.200
	Delatexing tank	90,6	70,1	34.014
	Second washing tank	16,7	3	2.009
	Alum	11	0	0
Yaque (Y)	source	54	9	3
	Delatexing tank	296	11	12
	Second washing tank	54	4	15
	Alum	20	14	221
Fernandez (F)	source	9	0	0
	Delatexing tank	438	253	0
	Second washing tank	51	36	0
	Alum	6	4	0

As conclusion of this work, fungi were found in all analyzed samples representing more than eight genera, moreover were present in high rate starting from field from flowers as well as crown parts. The diffusion occurs when bananas are processed through the dehanding and washing tanks. The final crown trimming followed by washing step and the application of protective products focusing on water quality, were the critical points of crown rot infections.

5 Chapter Five : Morphological and molecular characterization of strains belonging to genus *Fusarium*, isolated from crown tissues of organic bananas.

5.1 **Introduction**

The genus *Fusarium* was introduced by Link (1809). Many plants have at least one *Fusarium*-associated disease, where the need to identify strains and to attach names to them is indispensable (Leslie *et al.*, 2006). With the changes to the International Code of Nomenclature (ICN) providing the opportunity to have a single name for fungi of this nature, there has been a strong consensus amongst the community of researchers working on *Fusarium* that this name be used for all the fungi in the so-called terminal "*Fusarium* clade" (Geiser *et al.*, 2013). Species in *Fusarium* were described largely on the basis of the morphology of the crescent shaped septate conidia produced by most species as well as the shape and formation of other asexual spores described in "The *Fusarium* laboratory manual" by Leslie and his collaborators (2006). Relatively large amount of work done on the morphological taxonomy of these fungi, while important, it was often hampered by the lack of discriminatory taxonomic characters and the endophytic or inconspicuous nature of these fungi (Leslie *et al.*, 2006; Hyde *et al.*, 2014). Molecular -DNA sequence- data have emerged as key information for diagnostic and classification studies, although hampered in part by non-standard laboratory practices and analytical methods (Hyde *et al.*, 2014; Nilsson *et al.*, 2014). As well as it was considered problematic to differentiate species, i.e. not clearly fitting within a given species, but not clearly distinguishable from it either (Leslie *et al.*, 2006). Furthermore, the same genetic markers that give unparalleled phylogenetic resolution in some fungi may give none whatsoever in others (Hyde *et al.*, 2014). Studies based on biological species concepts also have been used to define some species like *Gibberella fujikuroi* species complex. A number of *Fusarium* species were important plant pathogens, as in a recent survey among the international community of plant pathologists, two species, *F. graminearum* and *F. oxysporum* were ranked fourth and fifth, respectively, on a list of top 10 fungal plant pathogens based on scientific/economic importance (Dean *et al.*, 2012; Geiser *et al.*, 2013). Recent investigations into a number of important species (e.g. *F. incarnatum*, *F. oxysporum*, *F. solani*) have provided evidence that they are complexes of phylogenetically distinct lineages that have been, or will eventually be described as species (Aoki *et al.*, 2005; O'Donnell *et al.*, 2009; Hyde *et al.*, 2014). We had a combination between morphological and molecular methods for the purpose of reaching correct identification of our *Fusarium* strains which was the most frequent genus associated with crown rot of organic bananas grown in Dominican Republic.

5.2 **Materials and methods**

5.2.1 Morphological identification

Almost 281 *Fusarium* isolates were used as monoculture purified colonies obtained, then they were inoculated in a central position as well as in three points in plates containing PDA and CLA (figure 5-1). They were submitted for morphological identification using two identification keys (Balmas *et al.*, 2000; Leslie *et al.*, 2006).

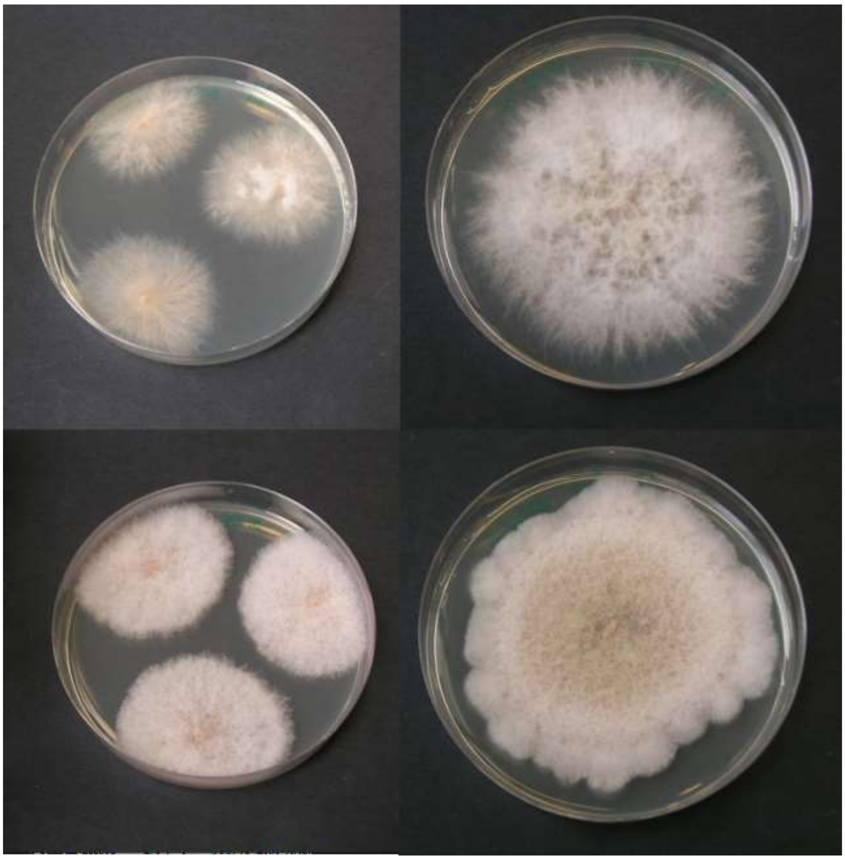


Figure 5-1. Examples of different purified Fusarium colonies and ways of inoculation on substrate surface media.

They were observed after 5,7 and 10 days of incubation at 24°C, and different characters were recorded and considered such as the colonies diameter, the colonies colors, the mycelial texture and their types, then observed under optical microscope to evaluate micro morphological aspects of reproductive structures present. Colonies were photographed during the final reading after 10 days. The microscopic observation must be conducted with great attention during the examination looking to different characters to be recorded as described in figure 5-2 that presented in *Fusarium* manual book (Leslie *et al.*, 2006).

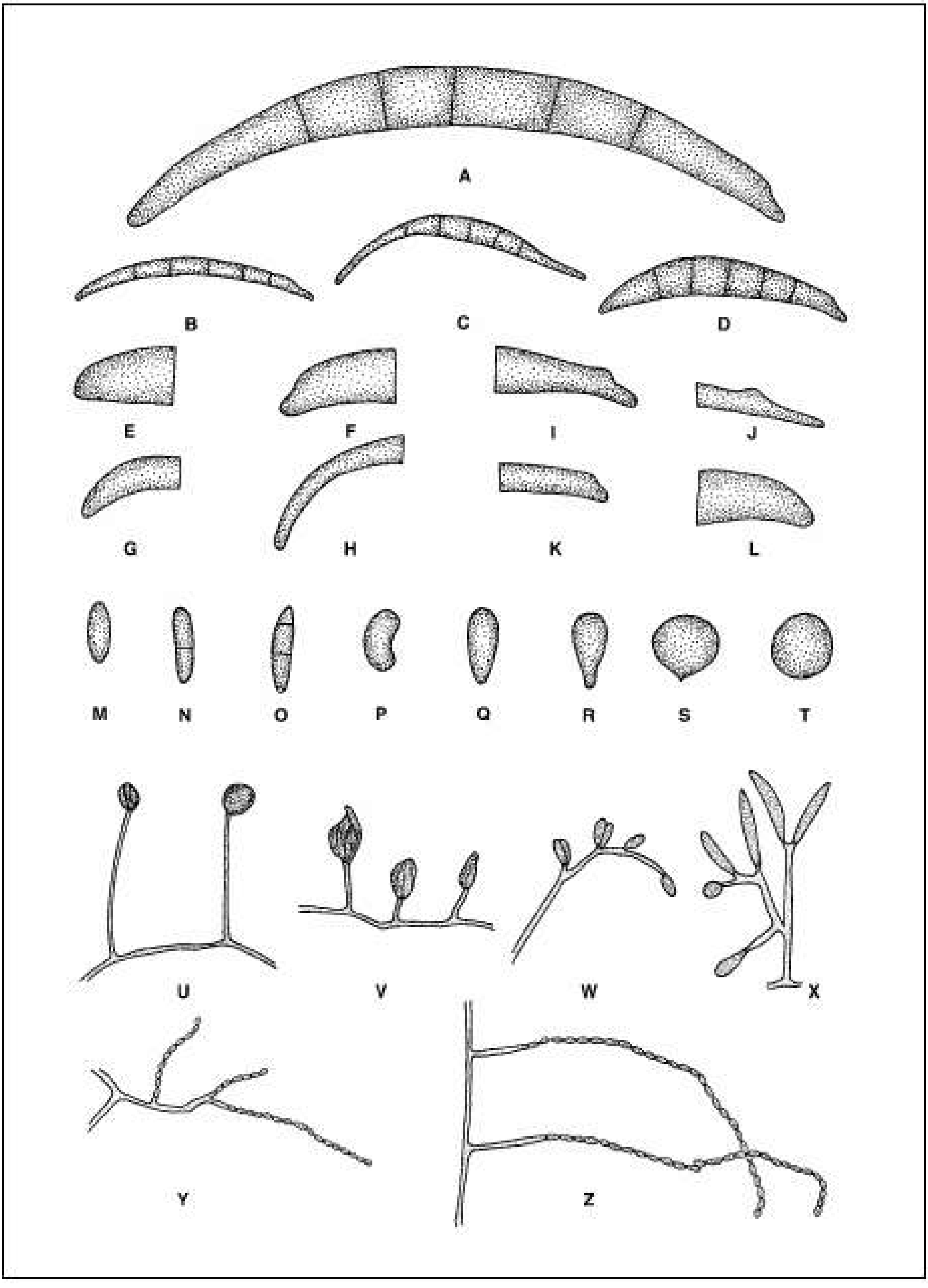


Figure 5-2. Spore morphology characters used in the identification of Fusarium species by Leslie et al., (2006) *.

* Drawings are idealized and not necessarily to the same scale. **A-D: Macroconidial shapes.** **A**. Typical *Fusarium* macroconidium. Apical cell on left, basal cell on right. **B**. Slender, straight, almost needle-like macroconidium, e.g., *F. avenaceum*. **C**. Macroconidium with dorsiventral curvature, e.g., *F. equiseti*. **D**. Macroconidium with the dorsal side more curved than the ventral, e.g., *F. crookwellense*. **E-H: Macroconidial apical cell shapes**. **E**. Blunt, e.g., *F. culmorum*. **F**. Papillate, e.g., *F. sambucinum*. **G**. Hooked, e.g., *F. lateritium*. **H**. Tapering, e.g., *F. equiseti*. **I-L: Macroconidial basal cell shapes**. **I.** Foot-shaped, e.g., *F. crookwellense*. **J**. Elongated foot shape, e.g., *F. longipes*. **K**. Distinctly notched, e.g., *F. avenaceum*. **L**. Barely notched, e.g., *F. solani*. **M-T: Microconidial spore shapes.** **M**. Oval. **N.** Two-celled oval. **O**. Three-celled oval. **P**. Reniform. **Q**. Obovoid with a truncate base. **R**. Pyriform. **S**. Napiform. **T**. Globose. **U-X: Phialide morphology.** **U**. Monophialides, e.g., *F. solani*. **V**. Monophialides, e.g., *F. oxysporum*. **W**. Polyphialides, e.g., *F. polyphialidicum*. **X**. Polyphialdes, e.g., *F. semitectum* (the former name of *F. incarnatum*). **Y-Z: Microconidial chains.** **Y**. Short chains, e.g., *F. nygamai*. **Z**. Long chains, e.g., *F. verticillioides*.

The macroconidia characters mainly observed from cultures grown on CLA (figure 5-3). The arrangement of the microconidia on and around the conidiogenous cell all are important and potentially diagnostic characters (figure 5-4, 5-5). The microconidia spores could form chain shape and in many cases, the observation of the conidiophores and the microconidia arranged can be conducted directly on the colonies grown in plate (figure 5-6), without altering the three-dimensional arrangement of the various structures, but to observe our targets at a high magnification, slides should be prepared. Therefore presence of chlamydospores was an important character in many *Fusarium* species descriptions (figure 5-7).

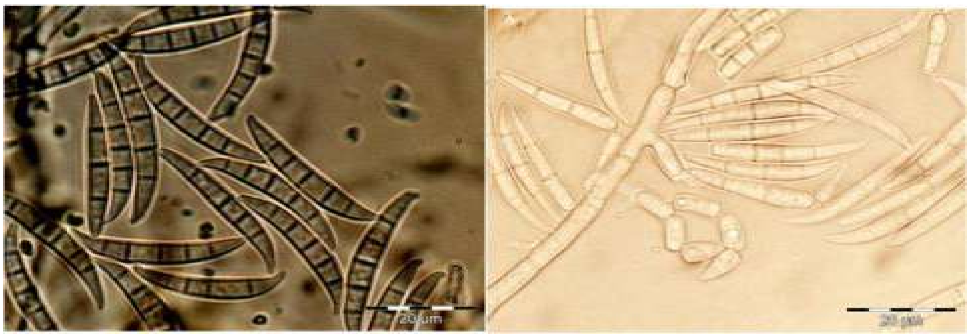


Figure 5-3. Fusarium macroconidia.

Figure 5-4. Fusarium microconidia.

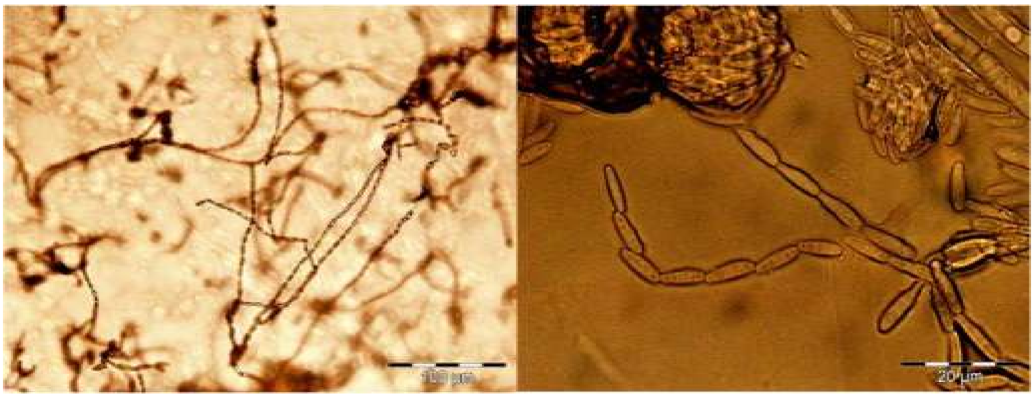


Figure 5-5. Microconidia arrangement in chains.

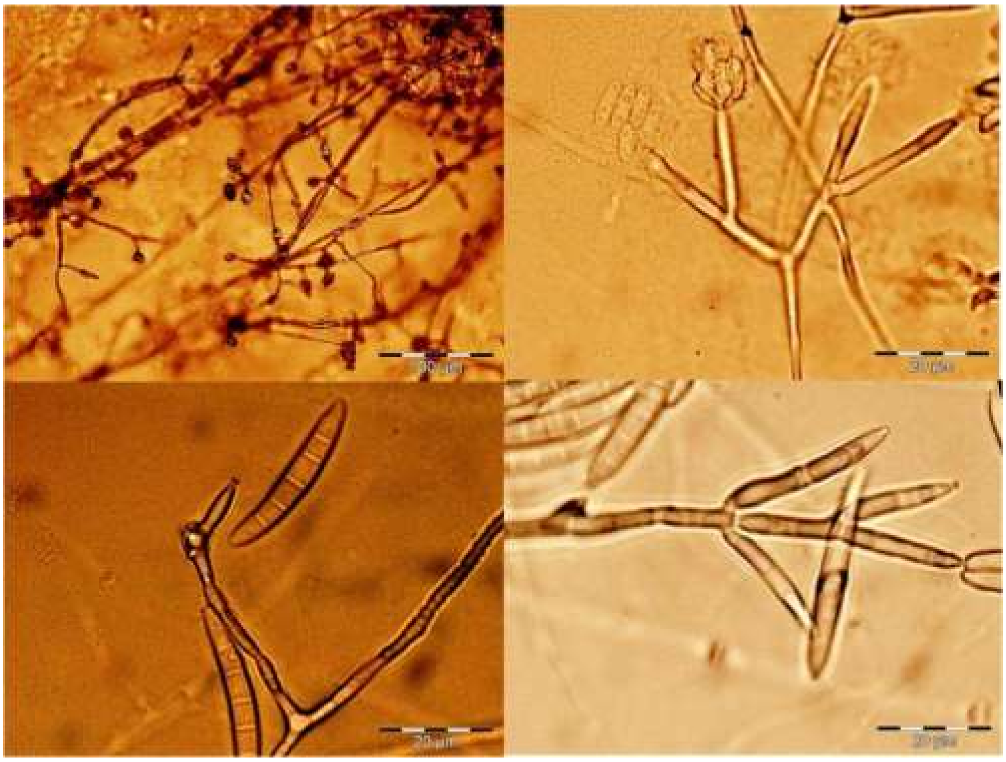


Figure 5-6. Different phialide morphology.

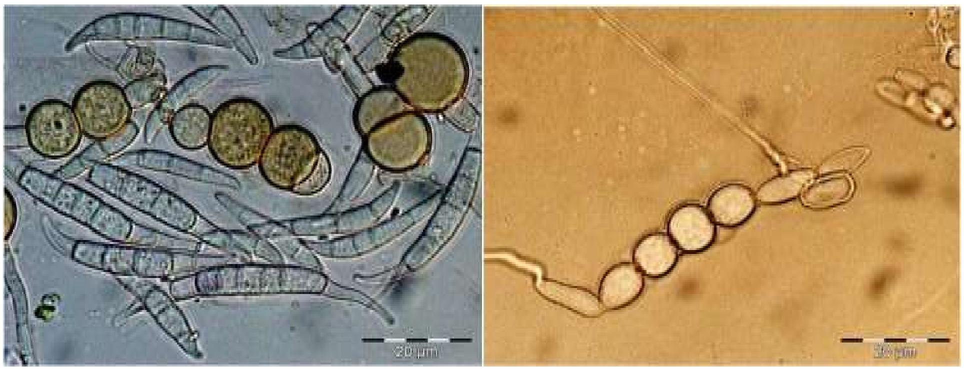


***Figure 5-7. Fusarium** chlamydospores.*

5.2.2 Molecular characterization

For DNA extractions and sequences same methods described in chapter two of this work were used, in additions the recommended and most frequently used gene for identification of species of *Fusarium* is the translation elongation factor 1α gene (TEF) and this is generally used for routine identifications, effectively performing a DNA barcoding function, and forms a significant component of the FUSARIUMID database (http://isolate.fusariumdb.org/; by Geiser et al. 2004) (Hyde *et al.*, 2014). Then the combination between the sequences from ß-tubulin and TEF were used in which they were able to resolve *G. fujikuroi* species complex (Fisher *et al.*, 1982). The same instractions and conditions described in tables 2-3, 2-4, 2-6 and figures 2-4, 2-5, 2-6 were used.

In order to do the phylogenetic analysis, DNA sequences from each strain were aligned visually with the Chromas programme, version 1.45 software (McCarthy 1998). Then, phylogenetic analyses were performed with CLC Genomics Workbench programme 3 (CLC bio, Aarhus, Denmark) on the individual and combined datasets, and the phylogenetic tree with maximum likehood in which the transition/transversion ratio was estimated and with the neighbor-joining option as well as in some cases an unweighted pair-group method with arithmetic (UPGMA) cluster analysis.

5.3 Results and discussions

5.3.1 Identification based on morpho-culture characters

The description of the colonies grown on PDA, looking to the colonies type and color from front side as well as the reverse one (table 5-1). (Annex B-28)

Table 5-1. Morphological characters of representative colonies grown on PDA.

strains code	Front side	Reverse side color
A15	White-cream color, almost covering all plate surface, mycelium is not compacted	Orange-cream as uniform color, darker with in spots in the center
A16	Mycelium is not compacted, and covers the whole plate with domed shap, darker orange spots in the center	Uniform cream color, darker orange spots in the center
B11	Mycelium is not compacted, and irregular white margin with domed shap, darker orange spots in the center and produce some rings like shap.	Uniform cream color, produce in the center some rings like shap.
B12	Mycelium is slightly compacted, and irregular white margin with domed shap	Uniform orange color, darker orange spots in the center
B5	Brown-cream with slightly domed shap, compacted, almost covering all plate surface and have irregular margin	Brown-orange.
C1-2	Purple-White. almost covering all plate surface	Purple and branched
C2-2	Purple-White, almost covering all plate surface and slightly compacted	Purple and branched
C2-4	Purple-White with a domed shap and slightly compacted	Purple and branched
C4-3	Purple slightly compacted, almost covering all plate surface	Purple and branched
C5-2	Brown-white, slightly compacted and almost covering all plate surface	Brown and branched
D125	Purple-White, almost covering all plate surface and compacted	Purple-red and branched
D127	White, with slightly domed shap, compacted, almost covering all plate surface	Purple
D143	Brown, almost covering all plate surface and slightly compacted	Orange and brown
D152	Purple-red with a domed shap, almost covering all plate surface and compacted	Purple-red, branched
D164	Purple with slightly compacted and almost covering all plate surface	Purple and branched
D166	Cream with a domed shap, compacted and almost covering all plate surface	Brown
D175	Purple-White, almost covering all plate surface, slightly compacted	Purple. Purple con contorno esterno cream, branched, centro Purple
D176	Brown-Purple, almost covering all plate surface	Brown-Purple and branched

D181	Brown with a domed shap, compacted, not covering all plate surface	Brown
D192	Purple-White, slightly compacted and almost covering all plate surface	Purple-red
D196	white with a domed shap, compacted	Orange
D198	Cream, with a domed shap, compacted, almost covering all plate surface	Cream
D20	Cream with a domed shap, compacted, almost covering all plate surface	Cream
D220	Purple-White, almost covering all plate surface and slightly compacted	Purple-red
D225	Purple-White with a domed shap, compacted, almost covering all plate surface	Purple
D227	Beige-cream and almost covering all plate surface with slightly compacted domed shap	Orange
D23	White-cream. almost covering all plate surface, compacted	Orange and slightly branched
D41	Cream with a domed shap, compacted, almost covering all plate surface	Cream-orange
D46	Purple-White. A domed shap, compacted, almost covering all plate surface, poi verso il centro è white-Purple pallido	Purple-cream
D51	Beige with slightly domed shap, compacted, almost covering all plate surface	Orange
D53	White-grigio with a domed shap, compacted	White and branched
D58	Brown-cream with slightly domed shap, compacted	Brown-cream
D60	Beige-cream and almost covering all plate surface, compacted	Cream
E 3	Orange-yellowish with a domed shap, compacted, almost covering all plate surface	Brown-orange
E1	Brown-white with slightly domed shap and compacted	Cream
E4	Purple. compacted ma di più sull'anello esterno che è white, l' e il centro sono Purple	Purple
F17	Beige-white. compacted, beige con alcune zone più bianche, almost covering all plate surface	Cream
F19	Brown-yellowish, almost covering all plate surface, slightly compacted	Cream
F20	Beige-brown, almost covering all plate surface and compacted	Brown
F21	Beige -white. almost covering all plate surface, compacted, e andando verso il centro beige	Brown
F25	Purple-White, slightly compacted and almost covering all plate surface	Purple-red, branched
F27	Purple-White, slightly compacted, almost covering all plate surface	Purple-red
F30	Brown and branched, slightly compacted	Brown-orange and branched

F31	Purple -white, with a domed shap, compacted, almost covering all plate surface	Purple -red and branched
F33	Purple, slightly compacted	Purple-brown
H4	Cream-yellowish with a domed shap, compacted, almost covering all plate surface	Orange-yellowish
H5	Beige-cream and slightly compacted	Orange
I21	Orange-yellowish with a domed shap, compacted	Orange
I22	Brown-orange, compacted	Brown orange
I24	Brown-cream. almost covering all plate surface	Brown-cream
I28	Beige-brown. almost covering all plate surface	Orange

Then the observation of reproductive structures of representative colonies grown on both PDA and CLA, made it possible to acquire the informations required by different keys used for the majority of our strains, firstly we used instructions of Balmas and coll (2000) (table 5-2).

Table 5-2. morphological results of some representative Fusarium strains.

Strains code	**Phialide morphology**	**Presence of microconidia**	**Microconidia shapes**	**Microconidial arrangement**	**Conidiophores**	**Chlamydospores**	**Presence of macroconidia**	**Macroconidia shapes**	**Number of septa**	**Macroconidial apical cell shapes**
A04	Monophialides	Yes	Oval	Form chains	Short	-	Yes	Slightly curvy and thin	≥3	Elongated or papillate
A09	Monophialides	Yes	Oval	Form chains	Long	Yes	-			
A15	Monophialides	No			Short	Yes	Yes	Slightly curvy	≥3	Elongated or papillate
A16	Monophialides	No			Short	Yes	Yes	Slightly curvy	≥3	Elongated or papillate
B01	Monophialides	Yes	Oval	Form chains	Long	Yes	Yes	Slightly curved but long	≥3	Blunt
B05	Monophialides	No			Short	Yes	Yes	Curvy	≥3	Elongated or papillate
B06	Monophialides	Yes	Oval	Form chains	Short	No	Rar e	Slightly curvy	2	Elongated or papillate
B11	Monophialides	No			Long	Yes	Yes	Slightly curvy	≥3	Elongated or papillate
B12	Monophialides	No			Long	No	Yes	Curvy, thin and long	≥3	Elongated or papillate
C1-1	Monophialides	Yes	Oval	Form chains	Long	Yes	Yes	Slightly curvy, too long	≥3	Elongated or papillate
C1-2	Monophialides/ Polyphialides	Yes	Oval	Form chains	Short	Yes	Yes	Slightly curved but long	≥3	Elongated or papillate
C1-3	Monophialides	Yes	Oval	Form chains	Short	Yes	Yes	Slightly curvy, diritti	≥3	Elongated or papillate
C1-4	Monophialides	Yes	Oval/ ellipsoidal	False head	Short	Yes	Yes	Slightly curvy	2	Blunt

C1-5	Monophialides	Yes	Oval	False head	Short	Yes	Yes	Slightly curved but long	≥3	Blunt
C2-2	Monophialides	Yes	Oval	False head	Short	Yes	Rare	Slightly curvy	2	Blunt
C2-3	Monophialides	Yes	Oval	Form chains	Long	-	Yes	Curvy, thin and long	≥3	Elongated or papillate
C2-4	Monophialides	Yes	Oval	False head	Short	Yes	Rare	Curvy, thin and long	≥3	Pointed
C3-2	Monophialides	Yes	Oval	Form chains	Long	Yes	Yes	Slightly curvy	≥3	Elongated or papillate
C4-1	Monophialides	Yes	Oval	Form chains	Short	Yes	No			
C4-3	Monophialides/ Polyphialides	Yes	Oval	Form chains	Short	No	Yes	Slightly curved but long	≥3	Pointed
C4-4	Monophialides/ Polyphialides	Yes	Oval	Form chains	Long	Yes	No			
C5-1	Monophialides	Yes	Oval	Form chains	Long	Yes	Yes	Slightly curvy	≥3	Blunt
C5-2	Monophialides	Yes	Oval	False head	Short	Yes	Yes	Slightly curvy	3	Blunt
D11	Monophialides	Yes	Oval	False head	Long	Yes	Rare	Slightly curvy	2	Blunt
D20	Monophialides	No			Short	Yes	Yes	Slightly curvy and thin	≥3	Pointed
D23	Monophialides	No			Long	Yes	Yes	Slightly curvy	≥3	Elongated or papillate
D41	Monophialides	No			Short	Yes	Yes	Sottili	≥3	Pointed
D44	Monophialides	No			Long	Yes	Yes	Highly curved	≥3	Pointed
D46	Monophialides/ Polyphialides	Yes	Oval	Form chains	Long	Yes	Yes	Curvy	1	Blunt
D51	Monophialides	No			Short	No	Yes	Slightly curved but long, sottili	≥3	Pointed
D52	Monophialides	Yes	Oval	False head	Long	Yes	Yes	Slightly curvy	≥3	Pointed
D53	Monophialides	Yes	Oval	False head	Long	Yes	No			
D56	Monophialides	Yes	Oval	False head	Long	Yes	No			
D58	Monophialides	No			Short	No	Yes	Slightly curvy and thin	≥3	Pointed
D60	Monophialides									
D67	Monophialides	Yes	Oval	False head	Short	Yes	Yes	Slightly curvy and thin	≥3	Elongated or papillate
D71	Monophialides	No			Long	No	Yes	Regular	≥3	Pointed
D125	Monophialides	Yes	Oval	False head	Short	No	Yes	Slightly curvy	≥3	Blunt
D127	Monophialides/ Polyphialides	No			Short	Yes	Yes	Slightly curved but long	≥3	Blunt
D143	Monophialides	No			Short	Yes	Yes	Slightly curved but long	≥3	Pointed
D146	Monophialides	Yes	Oval	Form chains	Short	No	Yes	Long	≥3	Blunt
D152	Monophialides	Yes	Oval	False head	Short	Yes	No			

D164	Monophialides	No			Short	Yes	Yes	Slightly curved but long	≥3	Pointed
D166	Monophialides	No			Long	Yes	Yes	Slightly curved but long	≥3	Pointed
D175	Monophialides	Yes	Oval/ ellipsoidal	False head	Long	Yes	No			
D176	Monophialides	Yes	Oval	False head	Short	Yes	Rar e			
D181	Monophialides	No			Long	Yes	Yes	Slightly curvy	≥3	Blunt
D187	Monophialides	Yes	Oval	False head	Long	Yes	Rar e	Slightly curvy	≥3	Blunt
D192	Monophialides	Yes	Globose	False head	Short	Yes	Yes	Diritti	3	Blunt
D196	Monophialides	Yes	Globose	False head	Short	Yes	Yes	Slightly curvy and thin	≥3	Elongated or papillate
D198	Monophialides									
D220	Monophialides	Yes	Oval	False head	Short	Yes	No			
D221	Monophialides	Yes	Oval	False head	Short	Yes	Rar e	Slightly curvy	≥3	Elongated or papillate
D225	Monophialides	No			Short	Yes	Yes	Slightly curvy	≥3	Blunt
D227	Monophialides	No			Short	Yes	Yes	Slightly curved but long, sottili	≥3	Pointed
E01	Monophialides	Yes	Oval	False head	Short	Yes	Yes	Slightly curvy	3	Blunt
E02	Monophialides	Yes	Oval	Form chains	Long	Yes	Rar e	Slightly curved but long	≥3	Elongated or papillate
E03	Monophialides	Yes	Oval	False head	Short	Yes	Yes	Long	≥3	Pointed
E04	Monophialides	Yes	Oval	Form chains	Short	No	Rar e	Slightly curvy	3	Blunt
E08	Monophialides	Yes	Oval	Form chains	Short	Yes	Yes	Slightly curvy and thin	≥3	Blunt
E11	Monophialides	Yes	Oval	Form chains	Long	No	Rar e		2	Blunt
F17	Monophialides	No			Short	Yes	Yes	Slightly curvy, too long	≥3	Pointed
F19	Monophialides	No			Short	Yes	Yes	Slightly curvy and thin	≥3	Pointed
F20	Monophialides	Yes	Oval	Form chains	Short	No	Yes	Slightly curved but long	≥3	Pointed
F21	Monophialides	Yes	Oval	Form chains	Short	No	Yes	Slightly curvy and thin	≥3	Elongated or papillate
F25	Monophialides	Yes	Oval	False head	Short	No	Rar e	Slightly curvy	2	Blunt
F27	Monophialides	Yes	Oval/ ellipsoidal	False head	Short	No	Rar e		1	Elongated or papillate
F30	Monophialides	Yes	Oval/ ellipsoidal	False head	Short	Yes	No			
F31	Monophialides	Yes	Oval	Form chains	Short	No	No			
F33	Monophialides	Yes	Oval	False head	Short	No	No			

F34	Monophialides	Yes	Oval/ ellipsoidal	False head	Long	Yes	No			
H01	Monophialides	No			Long	Yes	Yes	Curvy and thin	≥3	Pointed
H03	Monophialides	Yes	Oval		Short	Yes	No			
H04	Monophialides	Rare	Oval		Short	No	Yes	Slightly curved but long	≥3	Pointed
H05	Monophialides/ Polyphialides				Short	Yes	Yes	Slightly curved but long	≥3	Elongated or papillate
H13	Monophialides	Yes	Oval		Short	Yes	No			
H16	Monophialides	Yes	Oval	Form chains	Long	No	No			
H17	Monophialides	Yes	Oval	Form chains	Long	No	Yes		≥3	Elongated or papillate
I15	Monophialides	Yes	Oval	Form chains	Long	No	No			
I20	Monophialides	Yes	Oval	False head	Long	Yes	Yes	Curvy and long	≥3	Blunt
I21	Monophialides	Yes	Oval	False head	Short	Yes	Yes	Curvy, thin and long	≥3	Elongated or papillate
I22	Monophialides	Yes	Oval	False head	Short	Yes	Yes	Slightly curved but long	≥3	Elongated or papillate
I23	Monophialides	No			Short	Yes	Yes	Highly curved	≥3	Pointed
I24	Monophialides	No			Short	Yes	Yes	Curvy	≥3	Pointed
I28	Monophialides/ Polyphialides	No			Short	Yes	Yes	Fairly curved	≥3	Blunt

Moreover, it was not easy to distinguish the types of the different structures which required considerable attention and preparation of different slides. But the direct observation of the colonies in their plates, facilitate the observation of different fungal structures undisturbed as their three-dimensional structure. By using the instructions given by Leslie and his collaborators (2006), we were able to add more clear information into our database (table 5-3).

Table 5-3. Morphological characters related to different representative strains. All criteria were correlated and refers to figure 5-2, as a reference.

	Macroconidia*					Microconidia: dimenyesons (mm) of different forms recognized								Phialide	Chlamydo-spores	Microconidia chains
Code	N° of septa	Length (µm)	Type* (B); (C); (D)	Apical cell*: (E); (G); (H)	Basal cell* (I); (J); (K); (L)	Oval (M)	Two- oval (N)	Three-oval (O)	Reniform (P)	Obovoid (Q)	Pyriform (R)	Napiform (S)	Globose (T)	Mono- (U), (V) Poly-(W), (X)		
A15	3-5**	196	D	G	K	74	80-110	110		62	66-92	50	60	Poly (X)	Yes	Yes
A16	3 - 5	130	D	E	K	48-82	72				48			Poly (X)	Yes	No
B11	3-4-5**	180	D	G	K	42	64				54	44	46	Poly (X)	Yes	No
B12	3-5** - 7**	276	D	G	K		90- 96				84-96			Poly (X)	Yes	No
B5	4**-5	196	D	G	K	46	72- 94			50-114	54			Mono (V), Poly (X)	Yes	No
C1-2	3	268	B	G	K	56	56		56	54-78	50			Mono (V), Poly (X)	No	Yes
C2-2	3**-4	200	D	E	L	24- 90	86-98				62			Mono(U), Poly (X)	Yes	No
C2-4	3	184	D	E	L	50	86-118		46-56		40			Mono(U), mono (V), Poly (W)	Yes	No
C4-3	3	236	D	G	L	42-64	60		90	36	40-50			Mono (V), Poly (X)	Yes	Yes (short)
C5-2	3	226	D	E	K	36-70	92-100		74	70	70			Mono(U), Poly (X)	Yes	No
D12 5	3	196	D	E	L	36-40	66-96		62	60	56			Mono (V)	Yes	No
D12 7	5	106	D	E	L	50				50	60			Mono (V), Poly (X)	Yes	Yes (short)
D14 3	5	186	D	G	K		60-84	110		80	60-86		60	Poly (X)	Yes	No
D15 2		80	D	E	L	56	46-60	36		36				Mono(U), Poly (X)	Yes	Yes (short)
D16 4	3	216	D	E	L	60-74	110		54-60					Mono (V), Poly (X)	Yes	No
D16 6	3**-5**	236	D	G	L	40	100	86			46			Mono (V), Poly (X)	Yes	No
D17 5	3	248	B	E	I	66				64-50	76			Poly (X)	Yes	Yes (long)

D176	3	84	D	E	L		110-156		74	54	70-80			Mono(U), mono (V), Poly (X)	Yes	Yes (short)
D181	3**-5**	246	D	G	I		72	76		40	34-40	26	26	Poly (X)	Yes	No
D192	3	196	D	E	I	50	112							Mono (V), Poly (X)	Yes	Yes
D196	4**-5	268	D	G	I					50-70	60-76			Poly (W), Poly (X)	Yes	No
D198	3**-5	176	D	E	L	68	60-76				60			Mono (V), Poly (X)	Yes	No
D20	3-5**	150	D	E	K	76	60							Poly (X)	No	No
D220	3	248	B	G	L	36	120		100-110	110	70			Mono(V), Poly (W)	Yes	No
D225	3	176	D few	G	L	60-80	106		56	60	46			Mono (V)	Yes	Yes
D227	3-5-7**	156	D	G	L	Possible		Possible						Poly (X)	Yes	No
D23	5	200	D	G	L		80			68-80		56		Poly (X), (V)	Yes	No
D41	3-5**	236	D	G	I	44	64	90-110			46		24-30	Poly (W), Poly (X)	Yes	No
D46	3,-5	136	D few	E	L	100				76				Mono(U), Poly (X)	Yes	Yes
D51	3**-4-5**-7	316	D	G	K	70	110-116	120		64	68	56		Poly (X)	Yes	Yes
D53	3	184	B	E	L	36-70	100	64						Mono (V), Poly (W)	Yes	No
D58	3-5**-6	246	D	G	K									Poly (X)	Yes	No
D60	3**-5**	200	D	G	K		84							Poly (X)	Yes	No
E 3	3**-4	182	D	G	K		66	100-120		50				Poly (X)	Yes	No
E1	3**-5**-6**-7	194	D	G	L	74	72-80	120			72			Poly (W), Poly (X)	Yes	No
E4	3	244	D	G	I	80	136			86-90				Mono(U), Poly (X)	NO	Yes (short)
F17	5	230	C	H	J		62			120	40			Poly (X)	Yes	No
F19	5	200	D	E	K	40	86-90	110-168			60			Poly (W), Poly (X)	Yes	No

F20	3-5**	268	B	G	K		60	116		52				Poly (X)	Yes	No
F21	4-5**-6	210	D	G	K			80-130						Mono (V), Poly (X)	Yes	No
F25	3	200	B	E	I	70	40-112			40	40			Mono (V), Poly (X)	Yes	No
F27	3	196	D few	E	K	64- 82	86		66-86					Mono (V), Poly (W) or (X)	Yes	Yes
F30		Not present				72	80		40-44					Mono(U)	Yes	No
F31	3	Absent				76	64				50-64			Mono(U), Poly (W), Poly (X)	Yes	Yes (long)
F33	3-4**	300	B	G	K		46	46						Poly (W)	No	No
H4	3-5**	236	D	G	K		104	104						Poly (X)	Yes	No
H5	3-4-5**	152	D	G	K		56- 76		64	60				Poly (X)	Yes	No
I21	3 to 5	270	B	G	I		58-118	82			42-56			Poly (X)	Yes	No
I22	3-4-5**	200	D	G	I	44	64			60-66	40-54		42	Poly (X)	Yes	No
I24	3--5**-6-9**	248	D	G	K		64- 80	114		50-60				Poly (X)	Yes	No
I28	3-4-5**	196	D	G	K		68- 90	92	70		56-74	50-54		Poly (X)	Yes	No

* **A-D: Macroconidial shapes. A**. Typical *Fusarium* macroconidium. **B.** Slender, straight, almost needle-like macroconidium. **C.** Macroconidium with dorsiventral curvature. **D**. Macroconidium with the dorsal side more curved than the ventral. **E-H: Apical cell shapes. E**. Blunt. **F.** Papillate. **G.** Hooked. **H.** Tapering. **I-L: Basal cell shapes. I.** Foot-shaped. **J.** Elongated foot shape. **K.** Distinctly notched. **L.** Barely notched.

** This number was given more frequently.

Our results showed a high variability of strains used based on morphological characters, they showed also difficulties to group different representative strains considering all the criteria observed, but in some cases using just few together. Some characters specifications showed fuzziness or overlapping with each other e.g. the number of septa in macroconidia spores and the microconidia, sometimes it's difficult to consider it under one type. Then we summarized that our strains were mostly difficult to identified by morphology alone but at least we supposed different possibility of morphological identification (table 5-4).

Table 5-4. Different possibility of morphological identification as results of consulting different keys.

Code	Morphological identification		
	First possibility	**Second possibility**	**Third possibility**
F30	*F. solani*	*F. acuminatum*	*F. polyphialidicum*
F17	*F. incarnatum*	*F. equiseti*	*F. solani*
D58	*F. sporotrichioides*	*F. dimerun*	*F. equiseti*
D227	*F. camptoceras*	*F. incarnatum*	*F. solani*
D23	*F. incarnatum*	*F. dimerun*	*F. solani*
D196	*F. incarnatum*	*F. solani*	*F. sporotrichioides*
D143	*F. incarnatum*	*F. solani*	*F. sporotrichioides*
D181	*F. incarnatum*	*F. sporotrichioides*	*F. polyphialidicum*
I22	*F. incarnatum*	*F. sporotrichioides*	*F. solani*
D198	*F. solani*	*F. camptoceras*	*F. sporotrichioides*
F19	*F. solani*	*F. sporotrichioides*	*F. camptoceras*
A16	*F. solani*	*F. sporotrichioides*	*F. incarnatum*
H5	*F. sporotrichioides*	*F. acuminatum*	*F. incarnatum*
E 3	*F. sporotrichioides*	*F. camptoceras*	*F. incarnatum*
D60	*F. sporotrichioides*	*F. camptoceras*	*F. incarnatum*
B11	*F. sporotrichioides*	*F. incarnatum*	*F. camptoceras*
F20	*F. sporotrichioides*	*F. incarnatum*	*F. polyphialidicum*
D51	*F. sporotrichioides*	*F. incarnatum*	*F. polyphialidicum*
B12	*F. sporotrichioides*	*F. incarnatum*	*F. polyphialidicum*
A15	*F. sporotrichioides*	*F. incarnatum*	*F. polyphialidicum*
H4	*F. sporotrichioides*	*F. polyphialidicum*	*F. camptoceras*
D41	*F. sporotrichioides*	*F. polyphialidicum*	*F. incarnatum*
F21	*F. sporotrichioides*	*F. solani*	*F. chlamydosporum*
B5	*F. sporotrichioides*	*F. solani*	*F. incarnatum*
E1	*F. sporotrichioides*	*F. solani*	*F. polyphialidicum*
D166	*F. sporotrichioides*	*F. solani*	*F. polyphialidicum*
D20	*F. solani*	*F. mangiferae*	*F. sacchari*
I24	*F. sporotrichioides*	*F. camptoceras*	*F. incarnatum*
I21	*F. polyphialidicum*	*F. incarnatum*	*F. sporotrichioides*
I28	*F. sporotrichioides*	*F. polyphialidicum*	*F. camptoceras*
D164	*F. mangiferae*	*F. oxysporum*	*F. solani*
F25	*F. mangiferae*	*F. oxysporum*	*F. verticillioides*
D220	*F. mangiferae*	*F. sacchari*	*F. oxysporum*
D125	*F. mangiferae*	*F. solani*	*F. incarnatum*
D176	*F. proliferatum*	*F. solani*	*F. mangiferae*

C2-2	*F. solani*	*F. camptoceras*	*F. sporotrichioides*
C2-4	*F. solani*	*F. oxysporum*	*F. sacchari*
C5-2	*F. solani*	*F. sporotrichioides*	*F. incarnatum*
F27	*F. verticillioides*	*F. sacchari*	*F. mangiferae*
D225	*F. incarnatum*	*F. oxysporum*	*F. mangiferae*
C4-3	*F. mangiferae*	*F. incarnatum*	*F. oxysporum*
D127	*F. solani*	*F. camptoceras*	*F. chlamydosporum*
D46	*F. solani*	*F. camptoceras*	*F. verticillioides*
C1-2	*F. verticillioides*	*F. sacchari*	*F. mangiferae*
F31	*F. verticillioides*	*F. sacchari*	*F. solani*
D175	*F. mangiferae*	*F. verticillioides*	*F. proliferatum*
E4	*F. mangiferae*	*F. verticillioides*	*F. sacchari*
D192	*F. mangiferae*	*F. verticillioides*	*F. solani*
D53	*F. mangiferae*	*F. oxysporum*	*F. solani*
F33	*F. sacchari*	*F. verticillioides*	*F. mangiferae*
D152	*F. solani*	*F. verticillioides*	*F. proliferatum*

5.3.2 Identification based on molecular characterization

Generally, we have tried to overcome the difficulties of morphological identification by molecular meaning. The nucleotide sequences of all representatives strains were shown in (Annex A-1). Whereas the sequences results using ß-tubulin (table 5-5) and TEF (table 5-6) clarify different *Fusarium* species or species-complex.

Table 5-5. Sequences results of Fusarium species using ß-tubulin gene.

Code	First possibility			Second possibility		
	Identification	similarity	Accession n° in NCBI	Identification	similarity	Accession n° in NCBI
F30	*F. dimerum*	99%	JQ434533.1	*F. dimerum*	99%	JN235570.1
F17	*F. equiseti*	99%	KJ396338.1	*F. incarnatum*	99%	KJ020856.1
D58	*F. equiseti*	99%	KJ125874.1	*F. incarnatum*	98%	KJ396339.1
D227	*F. incarnatum*	99%	KJ020861.1	*F. equiseti*	99%	JX241676.1
D23	*F. incarnatum*	100%	KJ020858.1	*F. equiseti*	99%	JX241676.1
D196	*F. incarnatum*	99%	KJ020861.1	*F. equiseti*	99%	JX241676.1
D143	*F. incarnatum*	99%	KJ020861.1	*F. equiseti*	99%	JX241676.1
D181	*F. incarnatum*	99%	KJ020861.1	*F. equiseti*	99%	JX241676.1
I22	*F. incarnatum*	99%	KJ020858.1	*F. equiseti*	98%	JX241676.1
D198	*F. incarnatum*	99%	GQ857016.1	*F. equiseti*	99%	KF747330.1
F19	*F. incarnatum*	99%	KJ020861.1	*F. equiseti*	99%	JX241676.1
A16	*F. incarnatum*	98%	GQ857016.1	*F. equiseti*	98%	KF747330.1
H5	*F. incarnatum*	99%	KJ020861.1	*F. equiseti*	99%	JX241676.1
E 3	*F. incarnatum*	99%	GQ857019.1	*F. equiseti*	98%	AB587047.1
D60	*F. incarnatum*	98%	GQ857016.1	*F. equiseti*	98%	KF747330.1
B11	*F. incarnatum*	99%	KJ020861.1	*F. equiseti*	99%	JX241676.1
F20	*F. incarnatum*	99%	KJ020862.1	*F. equiseti*	99%	JX241676.1
D51	*F. incarnatum*	99%	KJ020861.1	*F. equiseti*	99%	JX241676.1
B12	*F. incarnatum*	99%	KJ020861.1	*F. equiseti*	99%	KJ125869.1

A15	*F. incarnatum*	99%	KJ020861.1	*F. equiseti*	99%	JX241676.1
H4	*F. incarnatum*	99%	KJ020861.1	*F. equiseti*	99%	JX241676.1
D41	*F. incarnatum*	99%	KJ020861.1	*F. equiseti*	99%	JX241676.1
F21	*F. incarnatum*	98%	KJ020856.1	*F. equiseti*	98%	JX241676.1
B5	*F. incarnatum*	99%	KJ020861.1	*F. equiseti*	99%	JX241676.1
E1	*F. incarnatum*	99%	KJ125869.1	*F. equiseti*	99%	JX241676.1
D166	*F. incarnatum*	99%	KJ020861.1	*F. equiseti*	99%	JX241676.1
D20	*F. incarnatum*	99%	KJ020858.1	*F. incarnatum*	99%	KJ020855.1
I24	*F. incarnatum*	99%	KJ020858.1	*F. incarnatum*	99%	KJ020865.1
I21	*F. incarnatum*	99%	KJ020861.1	*F. solani*	99%	KJ544188.1
I28	*F. incarnatum*	99%	KJ020861.1	*F. solani*	99%	KJ544188.1
D164	*F. oxysporum*	98%	KP765699.1	*F. sacchari*	99%	KC869340.1
F25	*F. oxysporum*	99%	KP765699.1	*F. sacchari*	99%	KC869340.1
D220	*F. oxysporum*	98%	KP765699.1	*F. sacchari*	99%	KC869340.1
D125	*F. oxysporum*	98%	KP765699.1	*F. sacchari*	99%	KC869340.1
D176	*F. oxysporum*	99%	KP765699.1	*F. sacchari*	99%	KC869340.1
C2-2	*F. oxysporum*	99%	KP765699.1	*F. sacchari*	99%	KC869340.1
C2-4	*F. oxysporum*	99%	KP765699.1	*F. sacchari*	99%	KC869340.1
C5-2	*F. oxysporum*	99%	KP765699.1	*F. sacchari*	99%	KC869340.1
F27	*F. oxysporum*	98%	KP765699.1	*F. sacchari*	99%	KC869340.1
D225	*F. proliferatum*	99%	KM044502.1	*F. proliferatum*	99%	AB725610.1
C4-3	*F. proliferatum*	99%	KM044502.1	*F. proliferatum*	99%	AB725610.1
D127	*F. proliferatum*	99%	KJ130326.1	*F. proliferatum*	99%	KJ125982.1
D46	*F. proliferatum*	99%	KJ130326.1	*F. proliferatum*	99%	KJ125982.1
C1-2	*F. proliferatum*	99%	KM044502.1	*F. solani*	98%	KC964153.1
F31	*F. verticillioides*	99%	KC964148.1	*F. musae*	99%	FN545372.1
D175	*F. verticillioides*	100%	KJ126060.1	*F. verticillioides*	100%	KJ020885.1
E4	*F. verticillioides*	99%	KC964148.1	*F. verticillioides*	99%	KC964147.1
D192	*F. verticillioides*	99%	KC964148.1	*F. verticillioides*	99%	KC964147.1
D53	*F. verticillioides*	98%	FR870326.1	*F. nygamai*	98%	KF466441.1
F33	*F. verticillioides*	98%	FR870326.1	*F. nygamai*	98%	KF466441.1
D152	*F. verticillioides*	97%	FR870326.1	*F. nygamai*	98%	KF466441.1

Table 5-6. Sequences results of Fusarium species using TEF gene.

Code	Consulting Fusarium-ID database			Consulting NCBI-blast database		
	Identification	**similarity**	**Accession n°**	**Identification**	**similarity**	**Accession n°**
D181	*F. incarnatum-equiseti*	100%	FD_01664_EF-1a	*F. incarnatum*	100%	KJ126171.1
H5	*F. incarnatum-equiseti*	100%	FD_01664_EF-1a	*F. equiseti*	100%	KM886212.1
E 3	*F. incarnatum-equiseti*	99%	FD_01639_EF-1a	*F. equiseti*	99%	JF508173.1
F20	not present			*F. equiseti*	100%	KP336404.1
D51	not present			*F. equiseti*	100%	KM886212.1
B12	*F. incarnatum-equiseti*	100%	FD_01664_EF-1a	*F. equiseti*	100%	KM886212.1
A15	*F. incarnatum-equiseti*	100%	FD_01692_EF-1a	*F. equiseti*	100%	KM886212.1
H4	*F. incarnatum-equiseti*	96%	FD_01643_EF-1a	*F. incarnatum*	100%	JX971222.2
D41	*F. incarnatum-equiseti*	99%	FD_01635_EF-1a	*F. incarnatum*	99%	JF270304.1
E1	*F. incarnatum-equiseti*	99%	FD_01664_EF-1a	*F. equiseti*	100%	KM886212.1
D166	*F. incarnatum-equiseti*	98%	FD_01683_EF-1a	*F. incarnatum*	100%	KR003731.1
D20	*F. incarnatum-equiseti*	100%	FD_01683_EF-1a	*F. incarnatum*	100%	KR003731.1
I24	*F. incarnatum-equiseti*	100%	FD_01683_EF-1a	*F. incarnatum*	100%	JX268996.1
I28	*F. incarnatum-equiseti*	99%	FD_01664_EF-1a	*F. incarnatum*	99%	HM770723.1
D164	*Gibberella fujikuroi*	100%	FD_01770_EF-1a	*F. sacchari*	99%	DQ465945.1
F25	*Gibberella fujikuroi*	99,70%	FD_01770_EF-1a	*F. sacchari*	100%	DQ465942.1
D220	*Fusarium* sp.	100%	FD_01859_EF-1a	*F. sacchari*	99%	HM347125.1
D125	*Gibberella fujikuroi*	99,70%	FD_01770_EF-1a	*F. sacchari*	100%	DQ465942.1
D176	*Gibberella fujikuroi*	99,70%	FD_01770_EF-1a	*F. sacchari*	100%	DQ465942.1
C2-2	*Gibberella fujikuroi*	99.54%	FD_01770_EF-1a	*F. sacchari*	99%	DQ465942.1
C2-4	*Gibberella fujikuroi*	100%	FD_01770_EF-1a	*F. sacchari*	99%	DQ465945.1
C5-2	*Gibberella fujikuroi*	99,70%	FD_01770_EF-1a	*F. sacchari*	100%	DQ465942.1
F27	*Gibberella fujikuroi*	100%	FD_01770_EF-1a	*F. sacchari*	100%	DQ465945.1
D225	*F. proliferatum*	99%	FD_01378_EF-1a	*F. proliferatum*	99%	KP732085.1
C4-3	*F. proliferatum*	99,70%	FD_01378_EF-1a	*F. proliferatum*	100%	KR856505.1
D127	*F. proliferatum*	99%	FD_01378_EF-1a	*F. proliferatum*	99%	KP732085.1
D46	*F. proliferatum*	99%	FD_01378_EF-1a	*F. proliferatum*	99%	KP732085.1
C1-2	*F. proliferatum*	99%	FD_01378_EF-1a	*F. proliferatum*	99%	KP732085.1
F31	*Fusarium* sp.	98,80%	FD_01278_EF-1a	*F. musae*	99%	KC599241.1
D175	*Gibberella fujikuroi*	99,70%	FD_01185_EF-1a	*F. verticillioides*	99%	KP732012.1
E4	*F. verticillioides*	100%	FD_01387_EF-1a	*F. verticillioides*	100%	KM598774.1
D192	*F. verticillioides*	99,70%	FD_01387_EF-1a	*F. verticillioides*	100%	FN179337.1
D53	*Gibberella fujikuroi*	98%	FD_01767_EF-1a	*F. pseudocircinatum*	99%	JF740710.1
F33	*Gibberella fujikuroi*	99%	FD_01176_EF-1a	*F. pseudocircinatum*	99%	GU377298.1
D152	*Gibberella fujikuroi*	97,90%	FD_01145_EF-1a	*Fusarium* sp.	98%	AF160309.1
D11	*F. solani*	99,45%	FD_01598_EF-1a	*F. solani*	100%	KP761172.1
D187	*F. solani*	100%	FD_01415_EF-1a	*F. solani*	100%	LN827985.1
E08	*F. incarnatum-equiseti*	99%	FD_01692_EF-1a	*F. equiseti*	99%	KM886212.1
H09	*F. incarnatum-equiseti*	99%	FD_01664_EF-1a	*F. equiseti*	100%	KM886212.1
D44	*F. oxysporum*	99%	FD_01227_EF-1a	*F. oxysporum*	99%	LN828039.1
D71	*F. incarnatum-equiseti*	100%	FD_01664_EF-1a	*F. equiseti*	100%	KM886212.1
D210	*F. incarnatum-equiseti*	98%	FD_01647_EF-1a	*F. equiseti*	99%	AB674278.1
D137	*F. solani*	98%	FD_01051_EF-1a	*F. solani*	99%	DQ247674.1

Furthermore, we performed the phylogenetic tree (figure 5-8) comparing our strains with selected sequences from published research or strains included in international collections and judging our results. moreover, we used to compare our *Fusarium incarnatum-equiseti* species complex to the references isolates presented in Fusarium-ID database and performed the phylogenetic tree (figure 5-9). It was clearly showed that our strains were belonging to *F. incarnatum*.

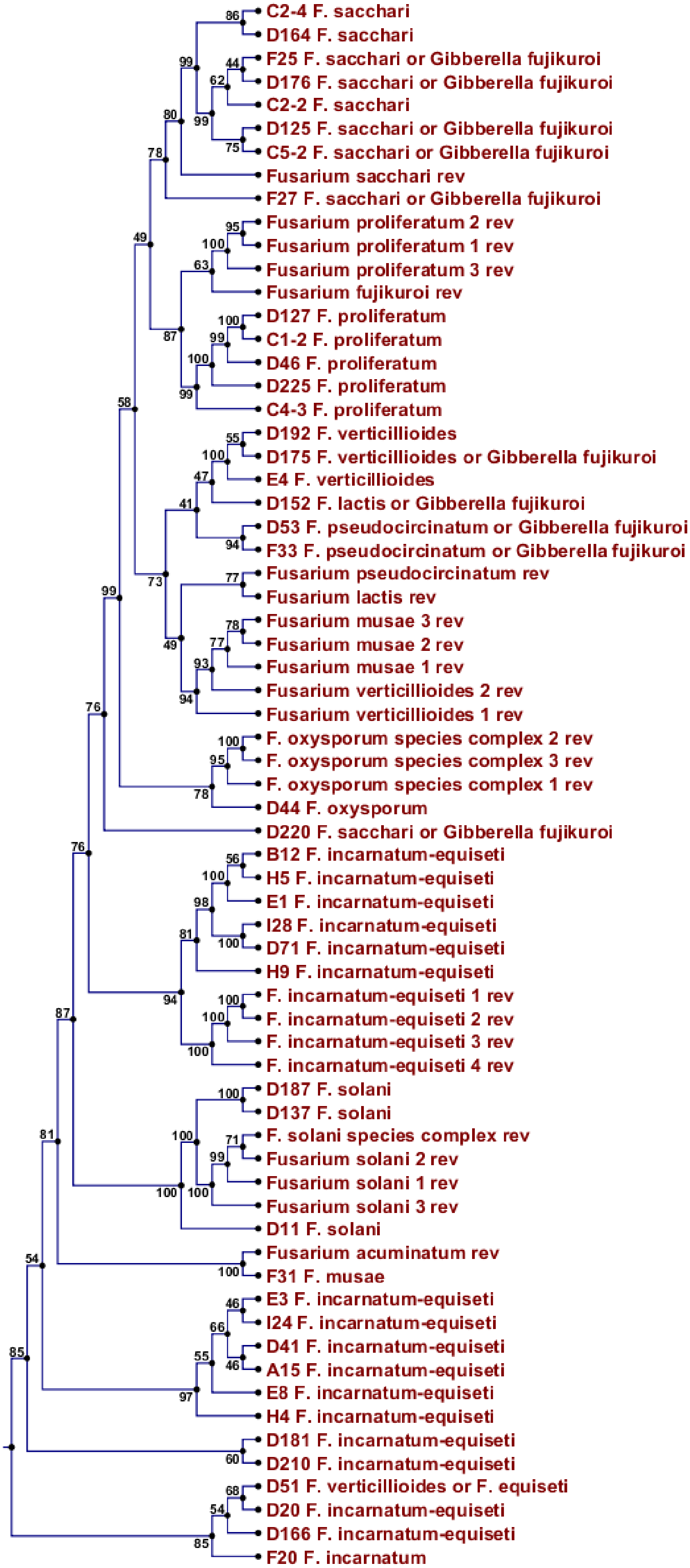


Figure 5-8. Phylogenetic relationships of Fusarium spp. sequences using TEF gene and compared with references isolates present in databases. The tree layout by UPGMA.

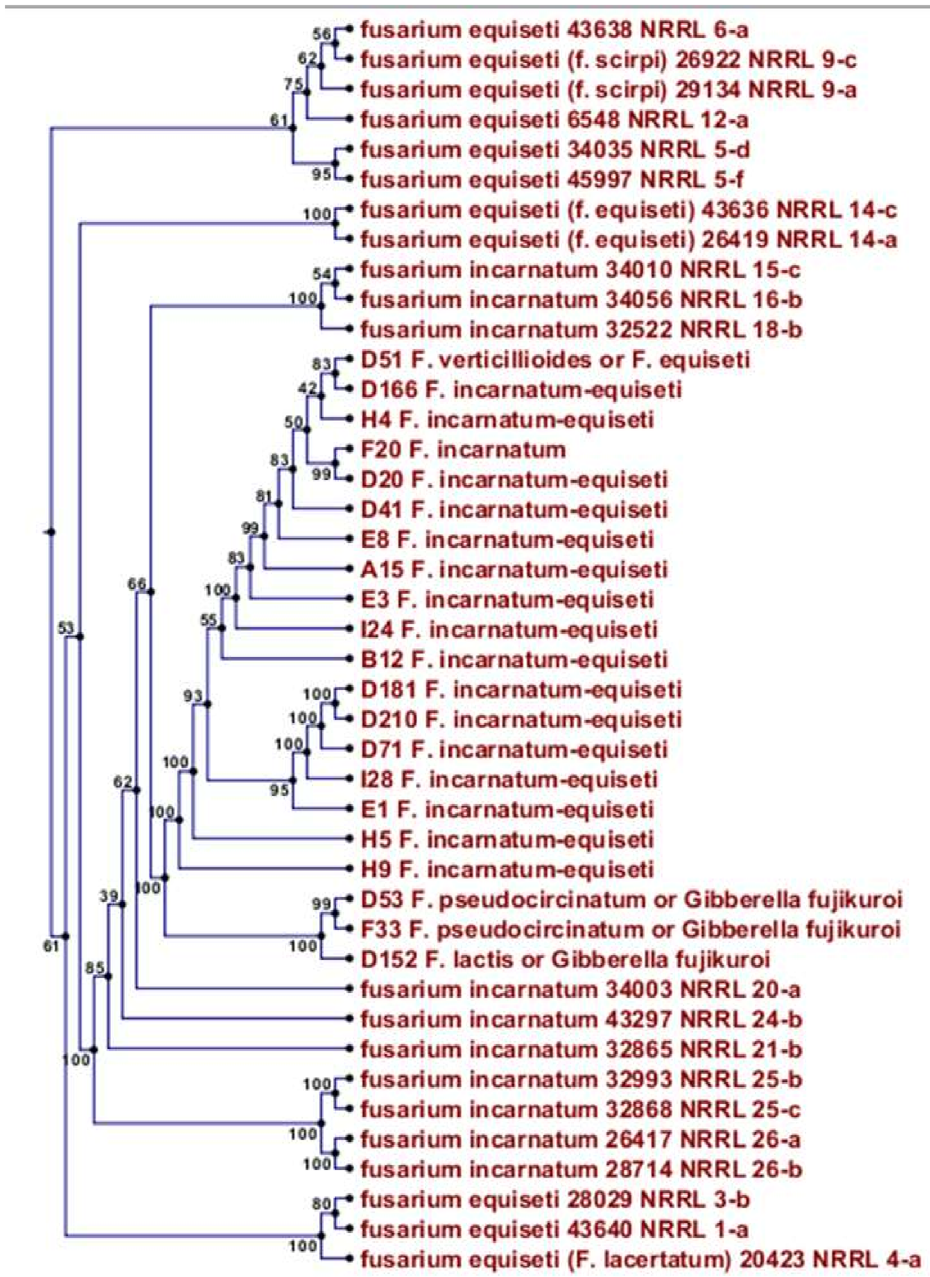


Figure 5-9. Phylogenetic relationships showed a comparison of our strains of F. incarnatum-equiseti species complex with the references isolates presented in Fusarium-ID database using TEF gene. The tree layout by neighbor-joining option.

The results based on morphological characters were finally compared with those based on the molecular sequences of both ß-tubulin and TEF. In some cases, molecular identification corresponded to the morphological analyses and allowed the identification of morphologically problematic cultures. In table 5-7, we reported the final identification of all representative *Fusarium* strains used in this work.

Table 5-7. Identification of all representative Fusarium strains.

Code	Identification results	Code	Identification results	Code	Identification results	Code	Identification results
D597	*F. dimerum*	I27	*F. incarnatum*	SD229	*F. incarnatum*	SD592	*F. sacchari*
F30	*F. dimerum*	I28	*F. incarnatum*	SD230	*F. incarnatum*	SD593	*F. sacchari*
SD01	*F. dimerum*	SD02	*F. incarnatum*	SD231	*F. incarnatum*	SD594	*F. sacchari*
A15	*F. incarnatum*	SD03	*F. incarnatum*	SD24	*F. incarnatum*	SD595	*F. sacchari*
A16	*F. incarnatum*	SD04	*F. incarnatum*	SD267	*F. incarnatum*	SD61	*F. sacchari*
B05	*F. incarnatum*	SD06	*F. incarnatum*	SD268	*F. incarnatum*	SD62	*F. sacchari*
B11	*F. incarnatum*	SD07	*F. incarnatum*	SD27	*F. incarnatum*	SD63	*F. sacchari*
B12	*F. incarnatum*	SD08	*F. incarnatum*	SD28	*F. incarnatum*	SD65	*F. sacchari*
C1-5	*F. incarnatum*	SD09	*F. incarnatum*	SD29	*F. incarnatum*	SD68	*F. sacchari*
D117	*F. incarnatum*	SD10	*F. incarnatum*	SD297	*F. incarnatum*	SD69	*F. sacchari*
D143	*F. incarnatum*	SD1000	*F. incarnatum*	SD30	*F. incarnatum*	SD70	*F. sacchari*
D156	*F. incarnatum*	SD1001	*F. incarnatum*	F31	*F. musae*	SD72	*F. sacchari*
D166	*F. incarnatum*	SD1002	*F. incarnatum*	SD440	*F. musae*	SD815	*F. sacchari*
D181	*F. incarnatum*	SD1015	*F. incarnatum*	SD441	*F. musae*	SD818	*F. sacchari*
D196	*F. incarnatum*	SD1020	*F. incarnatum*	A9	*F. oxysporum*	SD819	*F. sacchari*
D198	*F. incarnatum*	SD1021	*F. incarnatum*	D221	*F. oxysporum*	SD822	*F. sacchari*
D20	*F. incarnatum*	SD1036	*F. incarnatum*	D359	*F. oxysporum*	SD826	*F. sacchari*
D210	*F. incarnatum*	SD1037	*F. incarnatum*	D44	*F. oxysporum*	SD976	*F. sacchari*
D227	*F. incarnatum*	SD1038	*F. incarnatum*	D447	*F. oxysporum*	SD977	*F. sacchari*
D23	*F. incarnatum*	SD12	*F. incarnatum*	D448	*F. oxysporum*	C1-4	*F. solani*
D239	*F. incarnatum*	SD13	*F. incarnatum*	D465	*F. oxysporum*	D1024	*F. solani*
D253	*F. incarnatum*	SD139	*F. incarnatum*	D528	*F. oxysporum*	D11	*F. solani*
D277	*F. incarnatum*	SD14	*F. incarnatum*	D531	*F. oxysporum*	D137	*F. solani*
D358	*F. incarnatum*	SD140	*F. incarnatum*	H03	*F. oxysporum*	D187	*F. solani*
D361	*F. incarnatum*	SD141	*F. incarnatum*	SD31	*F. oxysporum*	D360	*F. solani*
D362	*F. incarnatum*	SD142	*F. incarnatum*	SD357	*F. oxysporum*	D468	*F. solani*
D41	*F. incarnatum*	SD145	*F. incarnatum*	SD39	*F. oxysporum*	D484	*F. solani*
D442	*F. incarnatum*	SD15	*F. incarnatum*	SD40	*F. oxysporum*	D52	*F. solani*
D466	*F. incarnatum*	SD151	*F. incarnatum*	C1-2	*F. proliferatum*	SD538	*F. solani*
D487	*F. incarnatum*	SD159	*F. incarnatum*	C4-3	*F. proliferatum*	D56	*F. solani*
D492	*F. incarnatum*	SD16	*F. incarnatum*	C4-4	*F. proliferatum*	SD978	*F. solani*
D504	*F. incarnatum*	SD160	*F. incarnatum*	D127	*F. proliferatum*	SD983	*F. solani*
D505	*F. incarnatum*	SD161	*F. incarnatum*	D225	*F. proliferatum*	SD984	*F. solani*
D51	*F. incarnatum*	SD162	*F. incarnatum*	D46	*F. proliferatum*	SD987	*F. solani*
D532	*F. incarnatum*	SD163	*F. incarnatum*	SD490	*F. proliferatum*	SD989	*F. solani*
D538	*F. incarnatum*	SD165	*F. incarnatum*	D491	*F. proliferatum*	SH19	*F. solani*
D58	*F. incarnatum*	SD167	*F. incarnatum*	D816	*F. proliferatum*	A04	*F. verticillioides*
D596	*F. incarnatum*	SD168	*F. incarnatum*	SD444	*F. proliferatum*	B01	*F. verticillioides*
D60	*F. incarnatum*	SD17	*F. incarnatum*	SD445	*F. proliferatum*	B06	*F. verticillioides*
D64	*F. incarnatum*	SD170	*F. incarnatum*	SD45	*F. proliferatum*	C1-1	*F. verticillioides*
D67	*F. incarnatum*	SD171	*F. incarnatum*	SD47	*F. proliferatum*	C1-3	*F. verticillioides*
D71	*F. incarnatum*	SD172	*F. incarnatum*	SD485	*F. proliferatum*	C2-3	*F. verticillioides*
SD817	*F. incarnatum*	SD173	*F. incarnatum*	SD485	*F. proliferatum*	C3-2	*F. verticillioides*
SD974	*F. incarnatum*	SD174	*F. incarnatum*	SD488	*F. proliferatum*	C4-1	*F. verticillioides*
E01	*F. incarnatum*	SD178	*F. incarnatum*	SD494	*F. proliferatum*	D175	*F. verticillioides*

Code	Identification results	Code	Identification results	Code	Identification results	Code	Identification results
E03	*F. incarnatum*	SD179	*F. incarnatum*	SD5	*F. proliferatum*	D192	*F. verticillioides*
E08	*F. incarnatum*	SD180	*F. incarnatum*	SD515	*F. proliferatum*	D464	*F. verticillioides*
F17	*F. incarnatum*	SD182	*F. incarnatum*	D152	*F. pseudocircinatum*	D49	*F. verticillioides*
F19	*F. incarnatum*	SD183	*F. incarnatum*	D53	*F. pseudocircinatum*	SD570	*F. verticillioides*
F20	*F. incarnatum*	SD184	*F. incarnatum*	F33	*F. pseudocircinatum*	D988	*F. verticillioides*
F21	*F. incarnatum*	SD185	*F. incarnatum*	SD42	*F. pseudocircinatum*	E02	*F. verticillioides*
F34	*F. incarnatum*	SD186	*F. incarnatum*	SD439	*F. pseudocircinatum*	E04	*F. verticillioides*
H01	*F. incarnatum*	SD188	*F. incarnatum*	SD527	*F. pseudocircinatum*	E11	*F. verticillioides*
H02	*F. incarnatum*	SD189	*F. incarnatum*	SD553	*F. pseudocircinatum*	H12	*F. verticillioides*
H04	*F. incarnatum*	SD19	*F. incarnatum*	SD554	*F. pseudocircinatum*	H14	*F. verticillioides*
H05	*F. incarnatum*	SD190	*F. incarnatum*	SD563	*F. pseudocircinatum*	H15	*F. verticillioides*
H06	*F. incarnatum*	SD191	*F. incarnatum*	C2-2	*F. sacchari*	H16	*F. verticillioides*
H07	*F. incarnatum*	SD197	*F. incarnatum*	C2-4	*F. sacchari*	H17	*F. verticillioides*
H08	*F. incarnatum*	SD203	*F. incarnatum*	C5-1	*F. sacchari*	H18	*F. verticillioides*
H09	*F. incarnatum*	SD206	*F. incarnatum*	C5-2	*F. sacchari*	I15	*F. verticillioides*
H10	*F. incarnatum*	SD208	*F. incarnatum*	D125	*F. sacchari*	SD443	*F. verticillioides*
H11	*F. incarnatum*	SD209	*F. incarnatum*	D146	*F. sacchari*	SD486	*F. verticillioides*
H13	*F. incarnatum*	SD21	*F. incarnatum*	D164	*F. sacchari*	SH20	*F. verticillioides*
I18	*F. incarnatum*	SD212	*F. incarnatum*	D176	*F. sacchari*	SH21	*F. verticillioides*
I19	*F. incarnatum*	SD213	*F. incarnatum*	D220	*F. sacchari*	SH22	*F. verticillioides*
I20	*F. incarnatum*	SD218	*F. incarnatum*	F25	*F. sacchari*	SH23	*F. verticillioides*
I21	*F. incarnatum*	SD219	*F. incarnatum*	F27	*F. sacchari*	SH24	*F. verticillioides*
I22	*F. incarnatum*	SD22	*F. incarnatum*	SD568	*F. sacchari*	SH25	*F. verticillioides*
I23	*F. incarnatum*	SD222	*F. incarnatum*	SD59	*F. sacchari*	SH26	*F. verticillioides*
I24	*F. incarnatum*	SD226	*F. incarnatum*	SD590	*F. sacchari*	SH41	*F. verticillioides*
I25	*F. incarnatum*	SD228	*F. incarnatum*	SD591	*F. sacchari*	SH42	*F. verticillioides*
I26	*F. incarnatum*						

6 Chapter Six : Morphological and molecular characterization of strains belonging to genus *Colletotrichum*, isolated from crown tissues of organic bananas.

6.1 **Introduction**

Colletotrichum musae is a plant pathogen primarily affecting the genus *Musa*, which includes bananas and plantains (Zakaria *et al.*, 2009). The main losses of bananas trade often occur during the shipment to the final market, by the continuous maturing of the fruit which is favorable for different pathogens. *C. musae* is playing an important role in charge of the defects of appearance and decays resulted associated with anthracnose and crown rot (Zakaria *et al.*, 2009). They have a great negative impact on fruits quality and market value driving down the banana price. Crown rot is a complex disease with different fungi involved including *C. musae* and it considered one of the maine postharvest diseases affects bananas in all producing countries (Reyes *et al.*, 1998; Krauss and Johanson, 2000). Organic banana cultivation in Dominican Republic suffers from crown rot disease which affecting the exportation of bananas. All isolates were principally identified as *C. musae* and as a genus it considered the second most frequent after *Fusarium*, accounting 7% and found in 13% of all samples included; as well as it had the most virulent strains, as reported in chapter 2 and 3. In this chapter we focused on identifying and characterizing representative strains of *Colletotrichum* spp., with morpho-cultural and biomolecular methods.

6.2 **Materials and methods**

6.2.1 Morphological examination

In this chapter we were studied 24 representative stains out of 36 isolates belonging to *Colletotrichum* spp. and all were isolated from crown tissues and mainly from internal crown tissues (see chapter 2). The strains were inoculated by placing a loop full of fungal culture taken from active growth grown on PDA plates, into a central position as well as in three points in plates containing PDA as well (figure 6-1).

Figure 6-1. Purified Colletotrichum colony showed two ways of inoculation on PDA.

As reported by Than *et al.* (2008), three cultures of each strains grown on PDA were used, and colony diameter with different characters were recorded daily for 7 days of incubation at 24°C. Average increase in diameter was calculated by measuring the average of daily growth. After 7 days; different characters were recorded and considered such as the colonies diameter, the colonies colors, the mycelial texture and their types, then observed under optical microscope to evaluate the size and shapes of 20 conidia harvested from each strain. Appressoria shape and size were recorded using a slide-culture technique described by Johnston and Jones (1997). In this technique we use cork-borer (10 mm^2) to cut circular cylinder piece of PDA, and then placed in an empty Petri dish, then the spore was taken from a sporulating culture and inoculated at the side edge of the PDA, with round glass slip placed over the inoculated agar (figure 6-2). After 5–7 days, appressoria formed across the underside of the cover slip and their shape and size were then recorded.

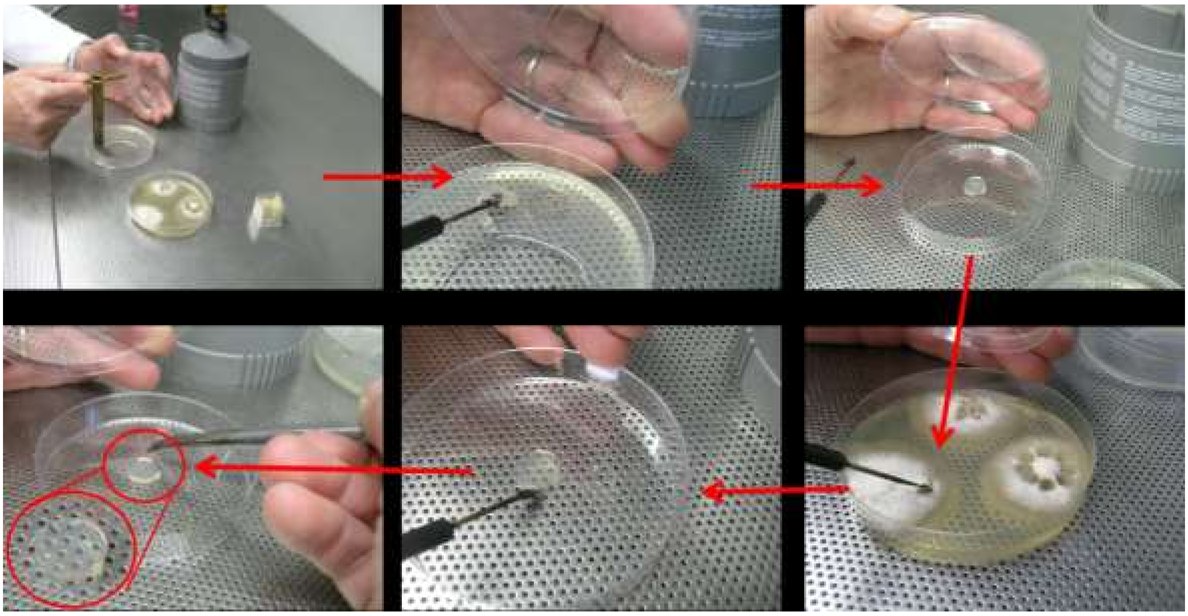


Figure 6-2. slide-culture technique.

6.2.2 Growth characters on solid media

In this experiment we have been used ten different growth media: PDA, OMA, WA, RA, CYA, MRBA, WGA, CLA, MEA and RV8. Three replications were performed for each strain with inoculation of the central plates for each media. The plates were incubated for 10 days at 24°C and then colony diameter was measured after 3, 5 and 10 days. The different colony characters were recorded in each medium by visual observation (Ranjitham Thangamani *et al.*, 2011).

6.2.3 Effect of pH on the growth of *Colletotrichum*

The effect of pH was studied according to the method followed by Ranjitham Thangamani *et al.* (2011) using PDA medium. This experiment were carried out using three replicates for each strain and different pH levels were applied: 4.5, 5.5, 6.5, 7.5 and 8.5. The plates were then incubated at 28°C for 10 days and then the diameter of mycelial growth was recorded at 3, 5, 7 and 10, as well as colony aspect.

6.2.4 Effect of temperature on the growth of *Colletotrichum*

The effect of the temperature was studied according to the method followed by Ranjitham Thangamani *et al.* (2011) using PDA medium. This experiment were carried out using three replicates for each strain and then the plates were incubated in various temperature degrees: 5°C, 10°C, 15°C, 20°C, 25°C and 30°C. Then the diameter of mycelial growth was recorded at 3, 5, 7 and 10 days of incubation. In addition, the differences in reproductive structures, the pigment production and colony aspect from both plate side were observed.

6.2.5 Biochemical examination

Our strains were tested for their ability to use citrate and tartrate as a carbon source, using medium B (as described in chapter 2) supplemented with 6 g/L of citric acid or ammonium tartrate and 0.012 g/L bromocresol purple (Waller *et al.*, 1993; Bridge *et al.*, 2008). Positive and negative controls containing, respectively, glucose 10 g/L or no additional carbon source were included for each strain. After autoclaving the media has distributed in Petri dishes that was left at room temperature for 24 hours to solidify. Media were inoculated with agar plugs (4 mm diameter) taken from the edge of a colony grown for 7 days on media B. Utilization was assessed by visual comparison of growth and a rise in the pH of the medium adequate to produce a dark blue to purple color of bromocresol purple instead of yellow (Waller *et al.*, 1993; Bridge *et al.*, 2008; Prihastuti *et al.*, 2009).

6.2.6 Molecular characterization

Same methods described in chapter two for DNA extractions were used, and then PCR amplification was acquired by using different primers:

- ITS1 and ITS4 to amplify ITS-1 - 5.8S - ITS-2 region of the nuclear rDNA, described in second chapter.
- AMF and AMR to amplify the intergenic region of apn2 and MAT1-2-1 genes, described in second chapter.
- Amplifying the satellite regions using different primers having the sequences given in table 6-1 (Freeman *et al.*, 1996; Thanos *et al.*, 1996).

Table 6-1. Sequences of primers used to amplify the satellite regions.

Primer	Sequenza 5' → 3'
M13 (minisatellite)	GAG GGT GGC GGT TCT
$(GACA)_4$ (microsatellite)	GAC AGA CAG ACA GAC A
$(GTG)_5$ (microsatellite)	GTG GTG GTG GTG GTG
$(CAG)_5$ (minisatellite)	CAG CAG CAG CAG CAG
$(GTGC)_4$ (minisatellite)	GTG CGT GCG TGC GTG C

Minisatellites and microsatellites were amplified using the PCR reactions that reported in tables 6-2, 6-3 (Thanos *et al.*, 1996; Rocchi *et al.*, 2010).

Table 6-2. Preparation of 30 µl PCR reaction for minisatellites primers.

	Concentration				**µl for one sample**	**unit**
	stock	**unit**	**reaction**	**unit**		
GO TAQ	5	U/µl	0,9	U	0,18	µl
BUFFER	5	x	1	x	6	µl
DNTP mix	2,5	mM	0,2	mM	2,4	µl
$MgCl_2$	25	mM	3	µM	3,6	µl
Primer	50	µM	0,5	µM	0,3	µl
DD water					16,32	µl
DNA					1,2	µl

Table 6-3. Preparation of 30 µl PCR reaction for microsatellites primers.

	Concentration				**µl for one sample**	**unit**
	stock	**unit**	**reaction**	**unit**		
GO TAQ	5	U/µl	0,9	U	0,18	µl
BUFFER	5	x	1	x	6	µl
DNTP mix	2,5	mM	0,2	mM	2,4	µl
$MgCl_2$	25	mM	3	µM	3,6	µl
Primer	50	µM	0,2	µM	0,12	µl
DD water					16,5	µl
DNA					1,2	µl

The amplification program was common for both mini- and microsatellites primers, with initial cycle of denaturation at 95°C for 5 min, 32 cycles of denaturation at 95°C for 15 sec, annealing at 50°C for 30 sec, extension at 72°C for 1.20 min, and final extension at 72°C for 6 min. For electrophoresis and the analysis of bands presented, same methods described in chapter 2 were used. As well as phylogenetic analysis done with same methods described in chapter 5.

6.3 **Results and discussions**

6.3.1 Identification based on morpho-culture characters

These results showed that all strains developed on PDA, for 10 days at 24°C, had similar colonies aspect: regards the growth rate, their color and the yellow pigmentation and the texture of the aerial mycelium that was whitish in color (table 6-4). But we realized small difference in amount and distribution of the sporulation, characterized by small masses conidia clusters, salmon-orange in color. In some strains they are scattered on the surface e.g. C3-1 and D48, while in other cases it was distributed in circular rings e.g C4-2, H30 and H31.

Table 6-4. Aspects of colony and its revers of Colletotrichum strains grown 7 days at 24°C.

Code	Back	Front
C3-1		
C4-2		
D48		
D128		

H28		
H29		
H30		
H31		
530 In1		
553 In1		

361 In1		
527 In1		
490 In2		
974 In1		
443 In1		
817 In1		

1027 In1		
355 In2		
355 In1		
598 In1		
1026 In		
570 In2		

The reproductive structures observed under light microscope resulted to have three different shapes of conidia (table 6-5), agreed with the description in the literature about the fungi belonging to the genus *Colletotrichum*. The oval shape was observed in all strains, but the cylindrical ones were observed in 20 out of 22 strains used, while elliptical shape were observed only in 11 strains.

Table 6-5. Three shapes of conidia and their images confirming the presence in our strains.

Code	**Oval**	**Cylindrical**	**Elliptical**
C3-1			
C4-2			
D48			
D128			
H28			

H29			
H30			
H31			
530 In 1			
553 In1			
361 In1			

527 In1			
490 In2			
974 In1			
443 In1			
817 In1			
1027 In1			

355 In2			
355 In1			
598 In1			
1026 In			
570 In2			

Using digital images, the dimensions of the various conidia type present in each strain were measured, and then average values were reported in table 6-6. Strain 527 In1 showed the maximum average of microconidia oval shape value equal to (87*40), and strain 355 In2 had the minimum one equal to (65*37) which conceded the smallest value. While the largest spore dimension among all conidia examined was reported under the cylindrical shape in strain 355 In1 with value equal to (143*39). The elliptical shape was average between maximum value of (113*44) in strain 1026. In and average of minimum value equal to (84*31) in strain D48. Then the distribution of the average size of each type of conidia for all strains showed that, the cylindrical conidia showed similar dimensions, and clearly differentiated from other two types (figure 6-3). In summary, the dimensions of various conidia shapes does not clearly separate between different strains studied, but the presence or not of these forms is the main difference.

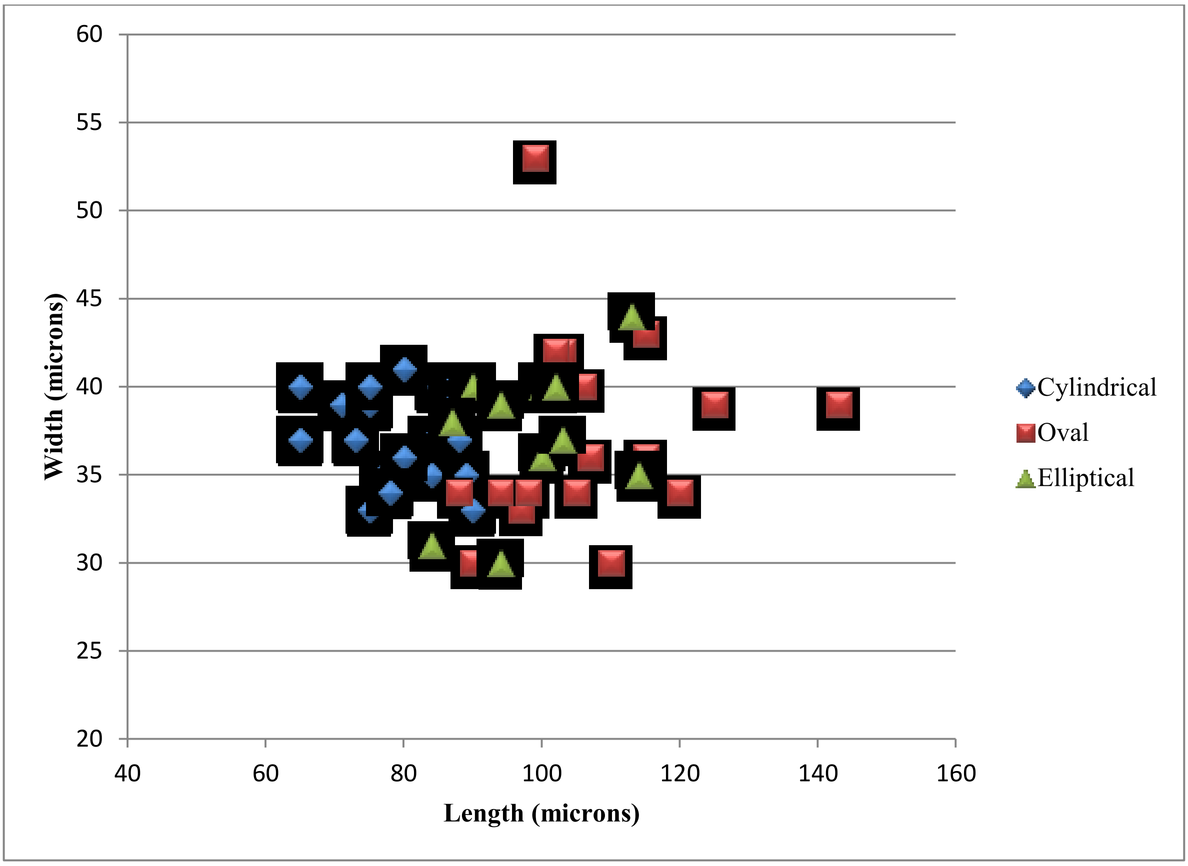


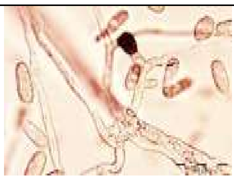
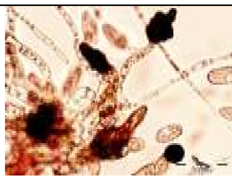
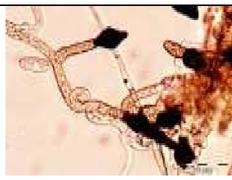
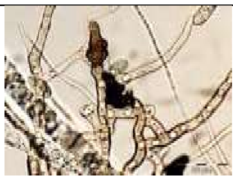
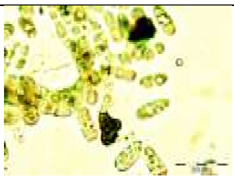
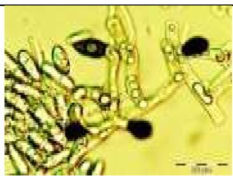
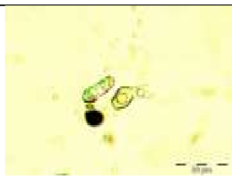
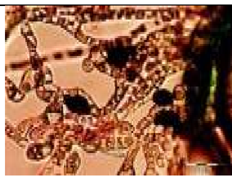
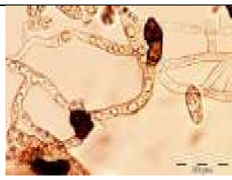
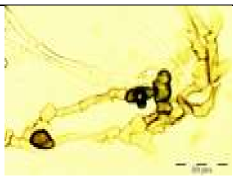
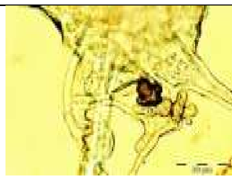
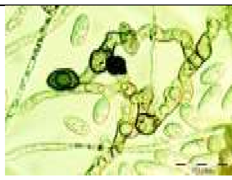
Figure 6-3. Distribution of the average size of each form of conidia presented and reported in all tested strains.

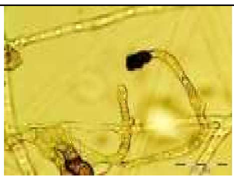
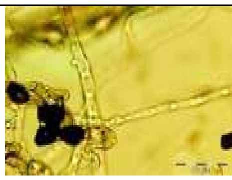
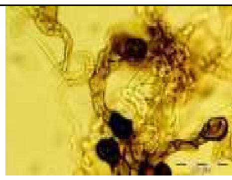
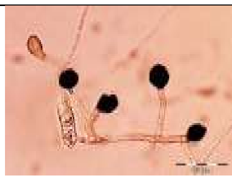
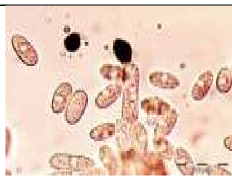
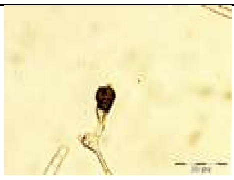
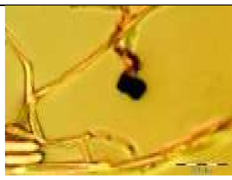
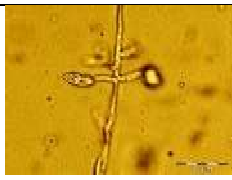
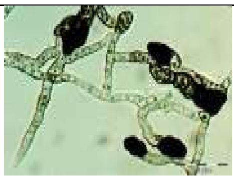
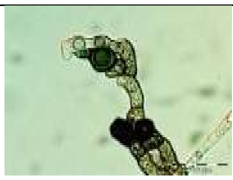
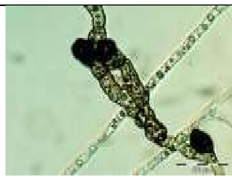
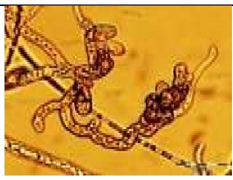
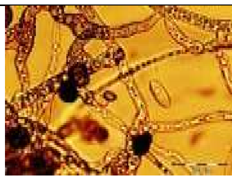
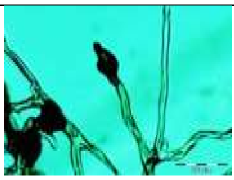
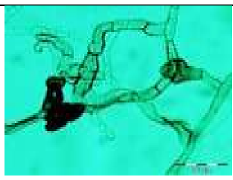
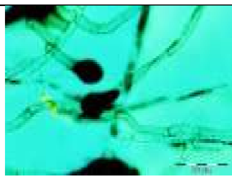
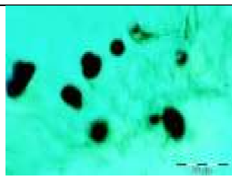
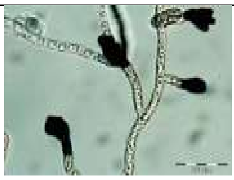
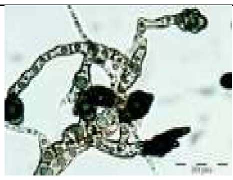
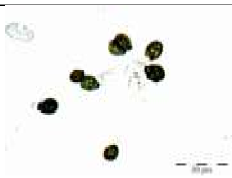
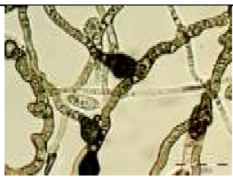
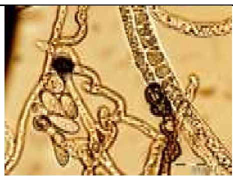
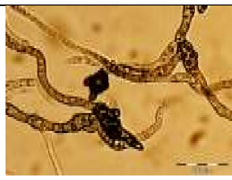
Table 6-6. Average, maximum value and minimum value of conidia dimension recorded in 22 strains under examination .

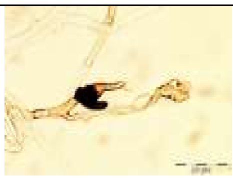
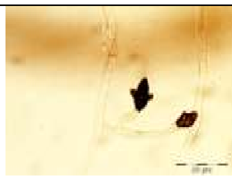
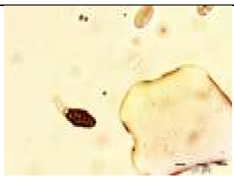
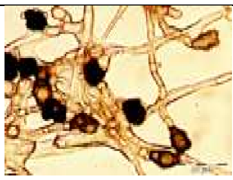
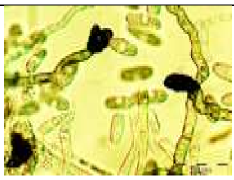
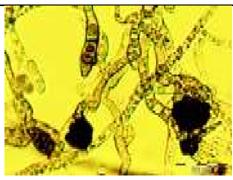
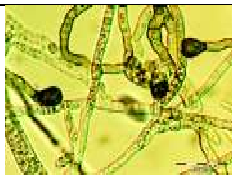
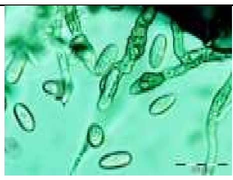
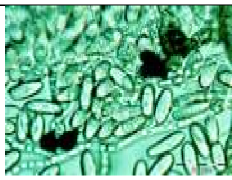
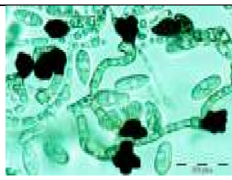
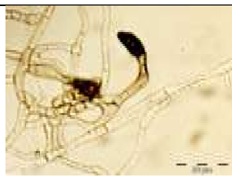
Code	Oval						Cylindrical						Elliptical					
	Average (µm)		**Maximum** (µm)		**Minimum** (µm)		**Average** (µm)		**Maximum** (µm)		**Minimum** (µm)		**Average** (µm)		**Maximum** (µm)		**Minimum** (µm)	
	Length	**Width**	**Length**	**Width**	**Length**	**Width**	**Length**	**Width**	**Length**	**Width**	**Length**	**Width**	**Length**	**Width**	**Length**	**Width**	**Length**	**Width**
C3-1	85	40	90	40	80	40	103	42	110	30	100	40	90	40	90	40	90	40
C4-2	75	33	88	34	40	40	105	34	120	32	94	36	-----	-----	-----	-----	-----	-----
D48	65	40	80	40	40	40	125	39	160	44	110	36	84	31	76	40	88	26
D128	84	37	90	36	80	30	115	43	180	66	94	36	-----	-----	-----	-----	-----	-----
H28	90	33	90	34	90	26	102	42	150	64	90	38	100	36	100	37	100	36
H29	88	40	114	34	60	40	99	53	98	50	100	40	-----	-----	-----	-----	-----	-----
H30	86	36	106	32	48	24	115	36	140	50	100	32	-----	-----	-----	-----	-----	-----
H31	84	35	100	46	60	40	105	40	120	50	100	36	-----	-----	-----	-----	-----	-----
530 In1	73	37	96	40	10	40	106	40	106	40	106	40	-----	-----	-----	-----	-----	-----
553 In1	77	35	80	36	70	34	97	33	120	40	88	30	114	35	118	34	110	36
361 In1	89	35	96	34	80	36	90	30	90	30	90	30	100	40	106	40	94	40
527 In1	87	40	114	38	84	40	88	34	88	34	88	34	-----	-----	-----	-----	-----	-----
490 In2	71	39	100	30	36	30	-----	-----	-----	-----	-----	-----	102	40	104	40	100	40
974 In1	87	39	90	38	66	50	90	30	90	30	90	30	103	37	110	40	100	30
443 In1	71	39	80	40	30	40	110	30	110	30	110	30	-----	-----	-----	-----	-----	-----
817 In1	88	37	100	40	60	40	120	34	120	34	120	34	-----	-----	-----	-----	-----	-----
1027 In1	80	36	80	36	80	36	100	40	100	40	100	40	94	39	110	38	70	40
355 In2	65	37	80	40	50	50	107	36	120	40	100	34	87	38	110	34	70	40
355 In1	75	39	90	38	50	40	143	39	300	46	90	34	-----	-----	-----	-----	-----	-----
598 In1	80	41	80	42	80	40	94	34	94	34	94	34	94	30	94	30	94	30
1026 In	75	40	90	40	70	40	-----	-----	-----	-----	-----	-----	113	44	180	50	80	40
570 In2	78	34	80	40	66	32	98	34	96	36	100	32	-----	-----	-----	-----	-----	-----

There were few differences in appressorial shape and size between strains. Appressoria shape produced by slide cultures varied from ovoid, clavate or slightly irregular to irregular in shape (table 6-7).

Table 6-7. Differences in appressorial shape and size between tested strains.

Code				
C3-1				
C4-2				
D48				
D128				
H28				
H29				
H30				
H31				

530 In1				
553 In1				
361 In1				
527 In1				
490 In2				
974 In1				
443 In1				
817 In1				
1027 In1				

355 In2				
355 In1				
598 In1				
1026 In				
570 In2				

6.3.2 Growth on solid media

Characteristics of different strain colonies were studied and reported in table 6-8 after grown on ten different media. Average increase in diameter of different strains showed that, they were able to grow on all the 10 media tested, but with relatively different rates. They were characterized by fast growth on PDA (figure 6-4), CYA (figure 6-5), WGA (figure 6-6), OMA (figure 6-7), MEA (figure 6-8) and RV8 (figure 6-9), as they able to colonies all the plates surfaces within five days of incubation. Using: RA (figure 6-10) and MRBA (figure 6-11), the growth was very slow and they reach after 10 days a maximum diameter of 30 mm and 20 mm, respectively. On WA medium, they characterized by constant growth (figure 6-12). Different from all, the average increase in diameter on CLA medium (figure 6-13) showed variation between strains, especially at the first 5 days of incubation whereas a group of 4 strains showed faster growth than others, and at the end, they reach the plate borders after 10 days. Others strains grown slowly, and some strains were difficult to follow-up due to unexpected contamination. Strain C3-1 showed some times slower growth than the others 21 strains as well as slightly different morphological characters with absence of white aerial mycelium. Images of colonies morphology of 22 strains grown on different solid media were shown in (Annex B from 7 to 16).

Table 6-8. Characteristics of strain colonies grown on ten different media and grouped by similarity.

Media	Day	Strain	Description of colonies	Aerial mycelium	Appressoria
PDA	5	C3-1, H28, 974 In1, 570 In2	Absence of acervuli, with orange exudate	White	Presente
		C4-2, D48, D128, H29, H30, H31, 530 In1, 553 In1, 361 In1, 527 In1, 490 In2, 443 In1, 817 In1, 1027 In1, 355 In1, 355 In2, 598 In1, 1026 In	Presence of many black acervuli, with orange exudate	White	Presente
	10	C3-1, H28, 974 In1, 570 In2	Absence of acervuli, with orange exudate	White	Presente
		C4-2, D48, D128, H29, H30, H31, 530 In1, 553 In1, 361 In1, 527 In1, 490 In2, 443 In1, 817 In1, 1027 In1, 355 In1, 355 In2, 598 In1, 1026 In	Presence of many black acervuli, with orange exudate	White	Presente
OMA	5	C4-2, D48, D128, H29, H30, H31, 530 In 1, 553 In1, 361 In1, 527 In1, 490 In2, 443 In1, 817 In1, 1027 In1, 355 In1, 355 In2, 598 In1, 1026 In , C3-1, H28, 974 In1, 570 In2	Presence of black acervuli, with orange exudate	White	Absent
	10	C4-2, D48, D128, H29, H30, H31, 530 In 1, 553 In1, 361 In1, 527 In1, 490 In2, 443 In1, 817 In1, 1027 In1, 355 In1, 355 In2, 598 In1, 1026 In , C3-1, H28, 974 In1, 570 In2	Presence of black acervuli, with orange exudate	White	Absent
WA	5	C4-2, D48, D128, H29, H30, H31, 530 In 1, 553 In1, 361 In1, 527 In1, 490 In2, 443 In1, 817 In1, 1027 In1, 355 In1, 355 In2, 598 In1, 1026 In , C3-1, H28, 974 In1, 570 In2	Transparent	Transparent	Absent
	10	C4-2, D48, D128, H29, H30, H31, 530 In 1, 553 In1, 361 In1, 527 In1, 490 In2, 443 In1, 817 In1, 1027 In1, 355 In1, 355 In2, 598 In1, 1026 In , C3-1, H28, 974 In1, 570 In2	Transparent	Transparent	Absent
RA	5	H30, H31, 530 In 1, 553 In1, 361 In1, 527 In1, 817 In1, 570 In2	Absence of acervuli	White	Absent
		C4-2, D48, D128, 490 In2, 443 In1,1027In, 355In1, 355 In2, 598 In, 1026 In, C3-1, H28, 974 In, H29			
	10	C4-2, D48, D128, H29, H30, H31, 530 In 1, 553 In1, 361 In1, 527 In1, 490 In2, 443 In1, 817 In1, 1027 In1, 355 In1, 355 In2, 598 In1, 1026 In , C3-1, H28, 974 In1, 570 In2	Absence of acervuli	White	Absent
CYA	5	D48, H29	White with presence of few black acervuli, with orange exudate	White	Absent
		530 In 1, 361 In1	White, with salmon color near the center	White	Absent
		C4-2, D128, H30, H31, 553 In1, 527 In1, 490 In2, 443 In1, 817 In1, 1027 In1, 355 In1, 355 In2, 598 In1, 1026 In , C3-1, H28, 974 In1, 570 In2	White with presence of few black acervuli	White	Absent

	10	D48, H29	White with presence of few black acervuli, with orange exudate	White	Absent
		530 In 1, 361 In1	White, with salmon color near the center	White	Absent
		C4-2, D128, H30, H31, 553 In1, 527 In1, 490 In2, 443 In1, 817 In1, 1027 In1, 355 In1, 355 In2, 598 In1, 1026 In , C3-1, H28, 974 In1, 570 In2	White with presence of few black acervuli	White	Absent
MBRA	5	C4-2, 527 In1, 1026 In	White, and absence of acervuli	White	Absent
		D48, D128, H29, H30, H31, 530 In 1, 553 In1, 361 In, 490 In2, 443 In, 817 In1, 1027 In, 355 In1, 355 In2, 598 In1, C3-1, H28, 974 In, 570 In2	Nothing		
	10	C4-2, D48, D128, H29, H30, H31, 530 In 1, 553 In1, 361 In1, 527 In1, 490 In2, 443 In1, 817 In1, 1027 In1, 355 In1, 355 In2, 598 In1, 1026 In , C3-1, H28, 974 In1, 570 In2	White, and absence of acervuli	White	Absent
WGA	5	D48, D128, H30, 527 In1, 490 In2, 443 In1, 817 In1, 1027 In, 355 In2, 1026 In, H28, 974 In, 570 In2	White with presence of few black acervuli	White	Not present
		C4-2, H29, H31, 530 In 1, 553 In1, 361 In1, 355 In1, 598 In1, C3-1,	White, and absence of acervuli	White	Not present
	10	D48, D128, H30, 527 In1, 490 In2, 443 In1, 817 In, 1027 In1, 355 In2, 1026 In, H28, 974 In1, 570 In2	White with presence of few black acervuli	White	Not present
		C4-2, H29, H31, 530 In 1, 553 In1, 361 In1, 355 In1, 598 In1, C3-1,	White, and absence of acervuli	White	Not present
CLA	5	D48, D128, 490 In2, 817 In1, 1027 In1, 355 In2, 598 In1,570 In2			
		C4-2, H29, H30, H31, 530 In 1, 553 In1, 361 In1, 527 In1, 443 In1, 355 In1, 1026 In , C3-1, H28, 974 In1,	White with ramification	White	Presente
	10	D48, D128, 490 In2, 817 In1, 1027 In1, 355 In2, 598 In1,570 In2			
		C4-2, H29, H30, H31, 530In 1, 553In1, 361In1, 527In, 443 In1, 355 In1,1026 In, C3-1, H28, 974In1	White with ramification	White	Presente
MEA	5	C4-2, D48, D128, H29, H30, H31, 530 In 1, 553 In1, 361 In1, 527 In1, 490 In2, 443 In1, 817 In1, 1027 In1, 355 In1, 355 In2, 598 In1, 1026 In , C3-1, H28, 974 In1, 570 In2	White, and absence of acervuli	White	Presente
	10	C4-2, D48, D128, H29, H30, H31, 530 In 1, 553 In1, 361 In1, 527 In1, 490 In2, 443 In1, 817 In1, 1027 In1, 355 In1, 355 In2, 598 In1, 1026 In , C3-1, H28, 974 In1, 570 In2	White, and absence of acervuli, with presence of orange masses of spores	White	Presente
RV8	5	C4-2, D48, D128, H29, H30, H31, 530 In 1, 553 In1, 361 In1, 527 In1, 490 In2, 443 In1, 817 In1, 1027 In1, 355 In1, 355 In2, 598 In1, 1026 In , C3-1, H28, 974 In1, 570 In2	White	White	Presente
	10	C4-2, D48, D128, H29, H30, H31, 530 In 1, 553 In1, 361 In1, 527 In1, 490 In2, 443 In1, 817 In1, 1027 In1, 355 In1, 355 In2, 598 In1, 1026 In , C3-1, H28, 974 In1, 570 In2	White	White	Presente

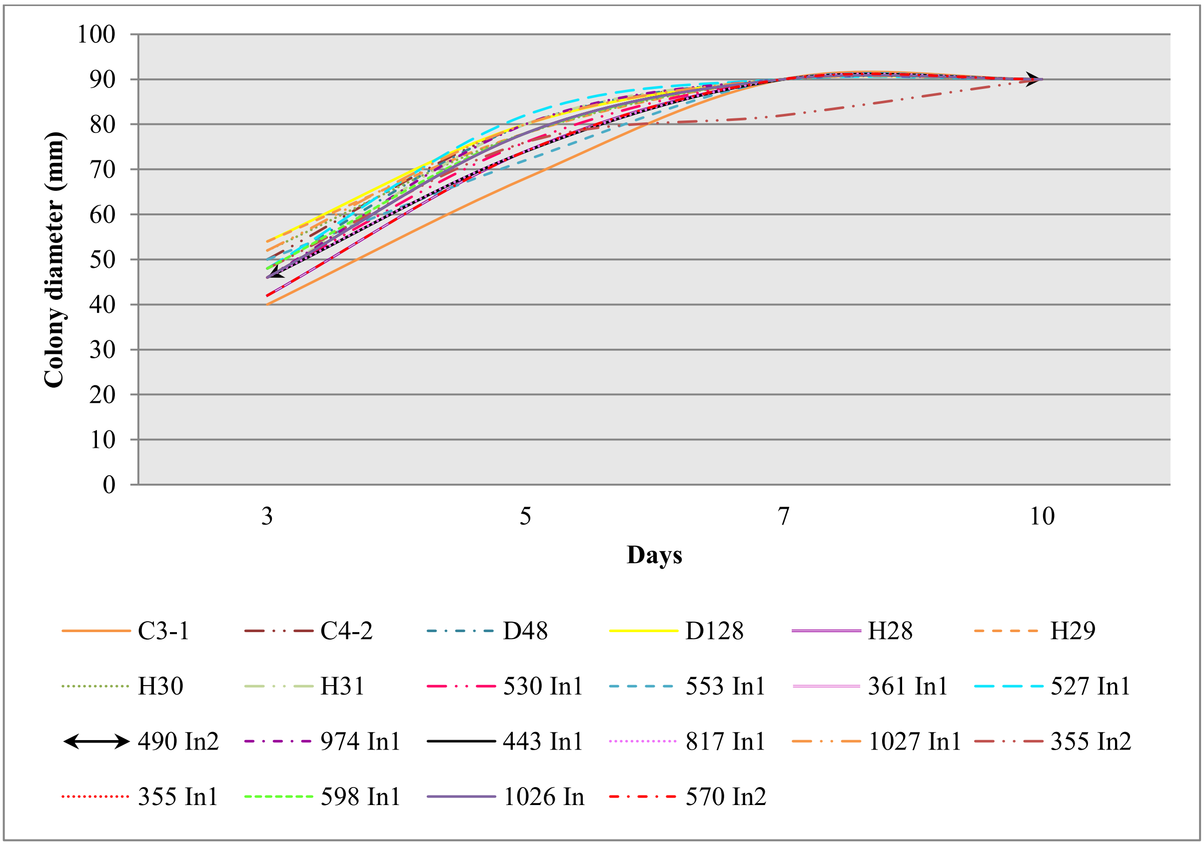


Figure 6-4. Growth rate of different strains grown on PDA.

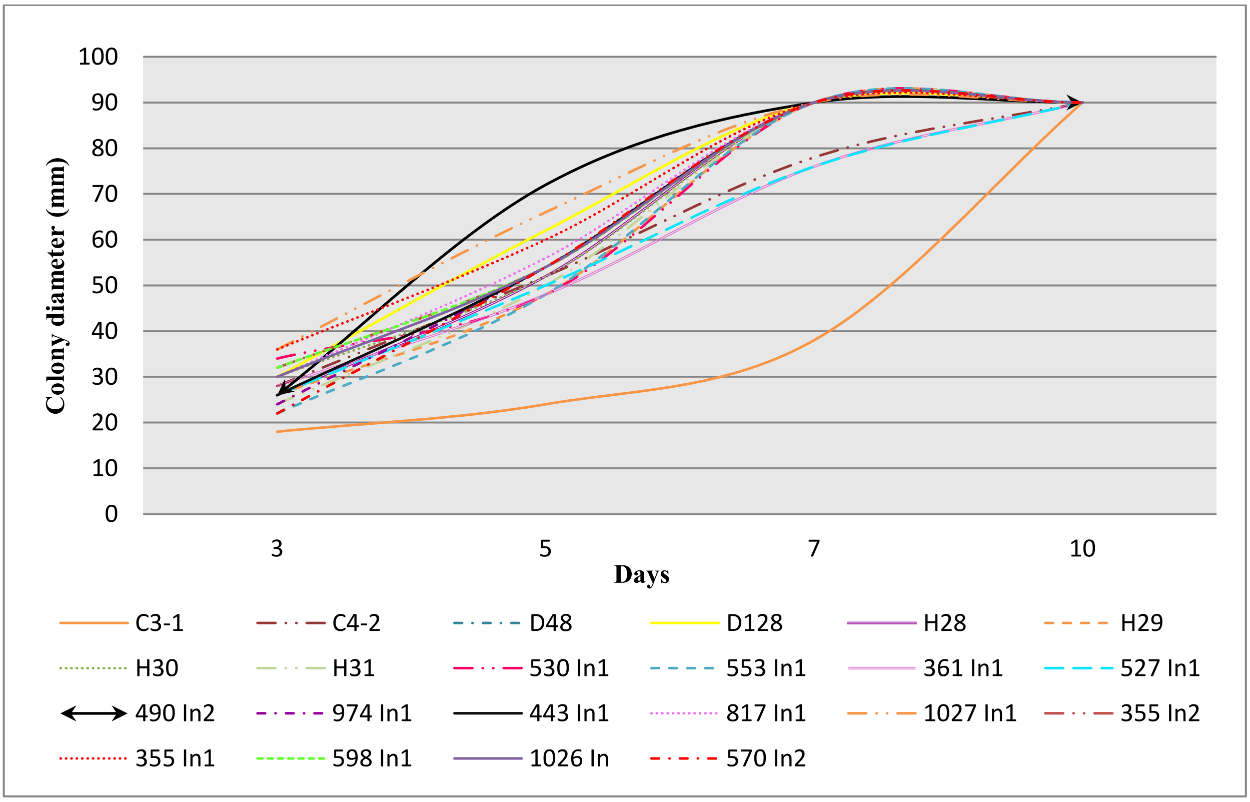


Figure 6-5. Growth rate of different strains grown on CYA.

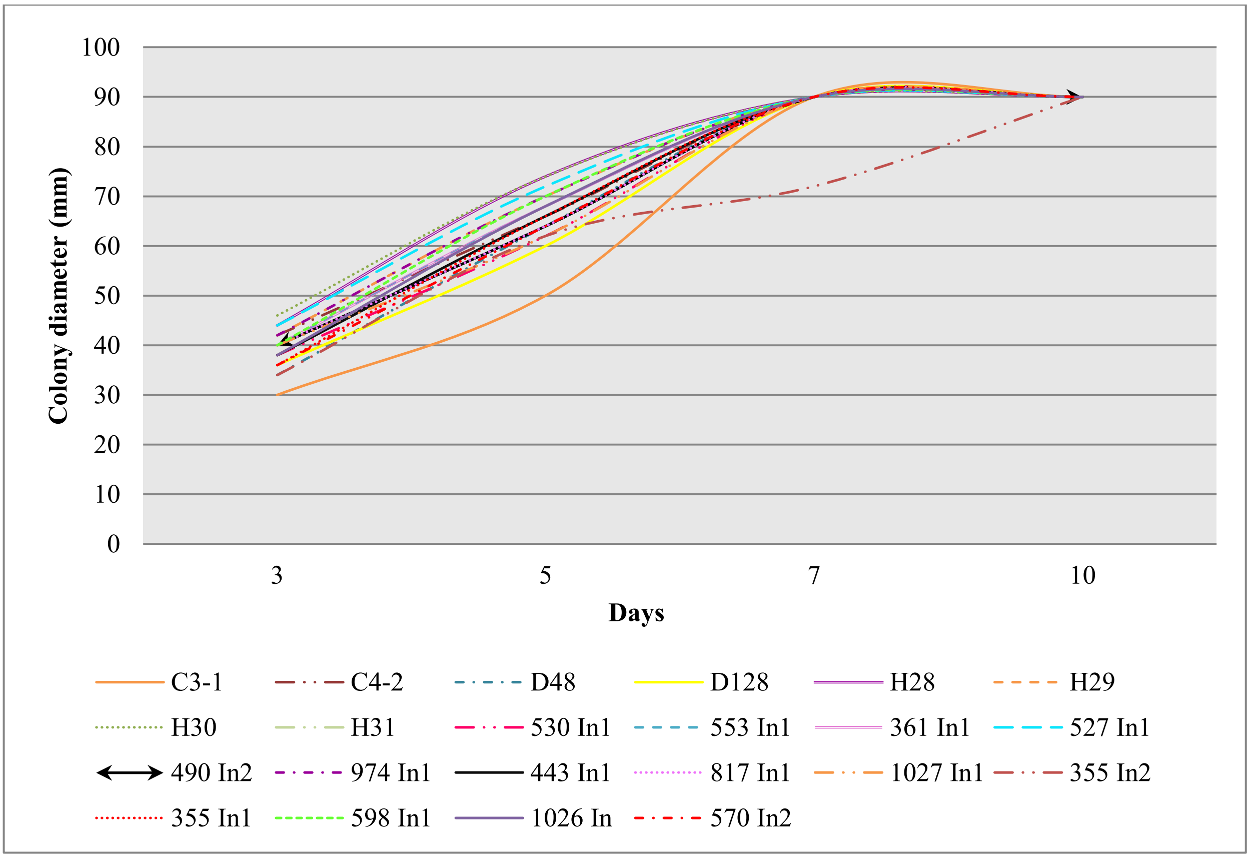


Figure 6-6. Growth rate of different strains grown on WGA.

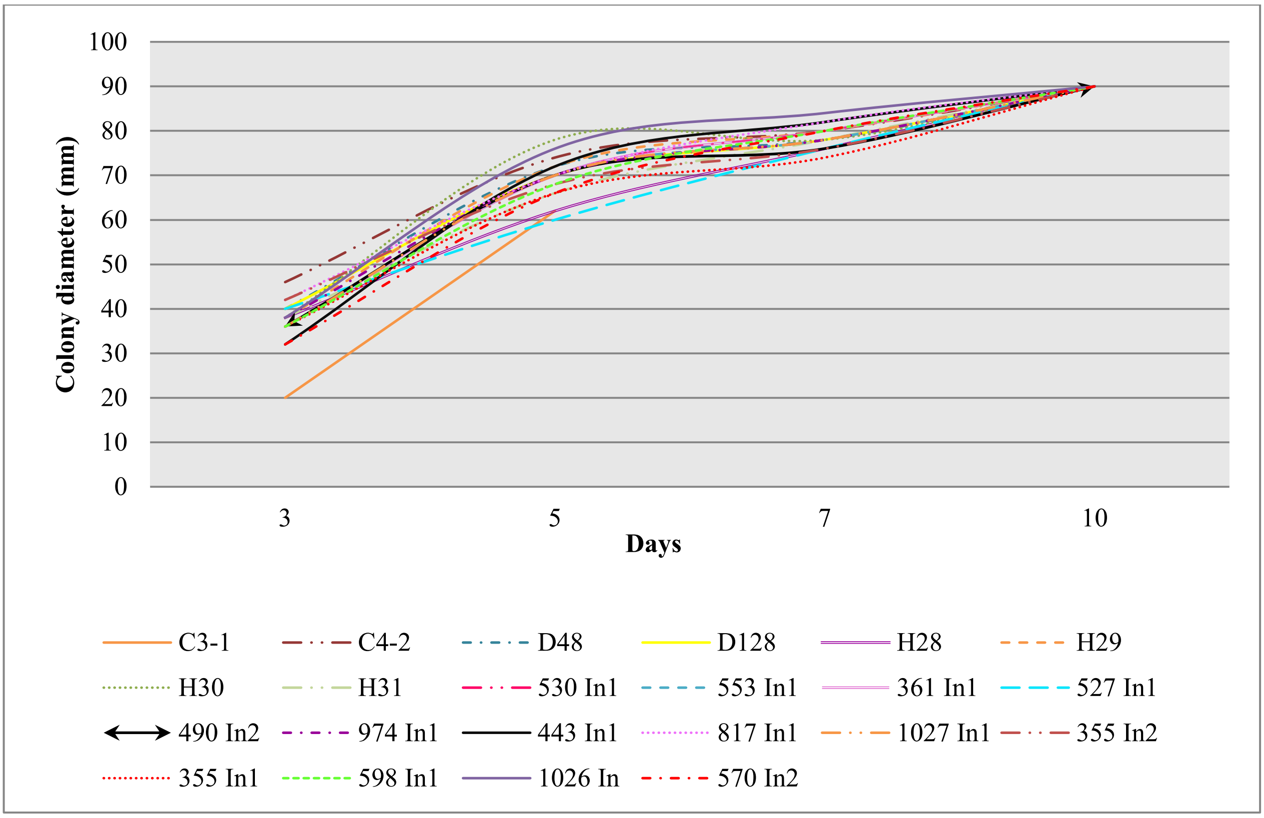


Figure 6-7. Growth rate of different strains grown on OMA.

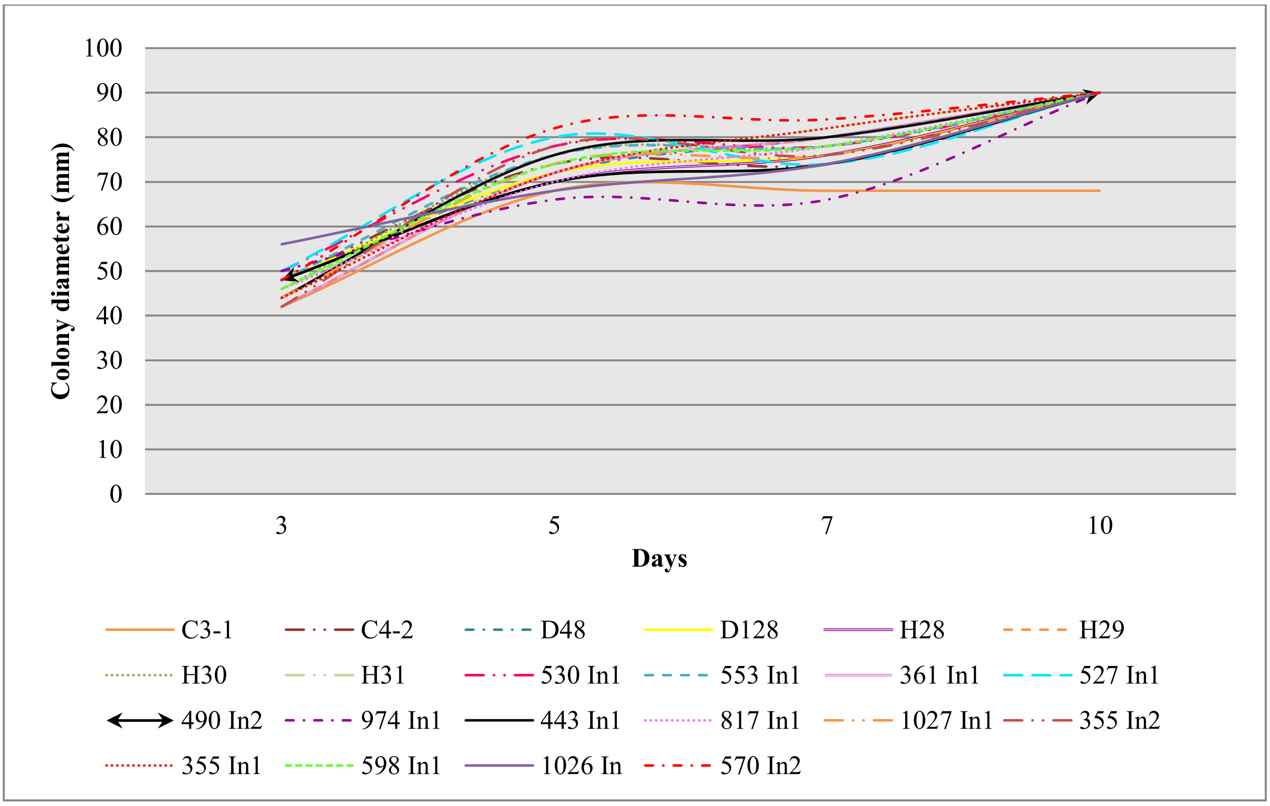


Figure 6-8. Growth rate of different strains grown on MEA.

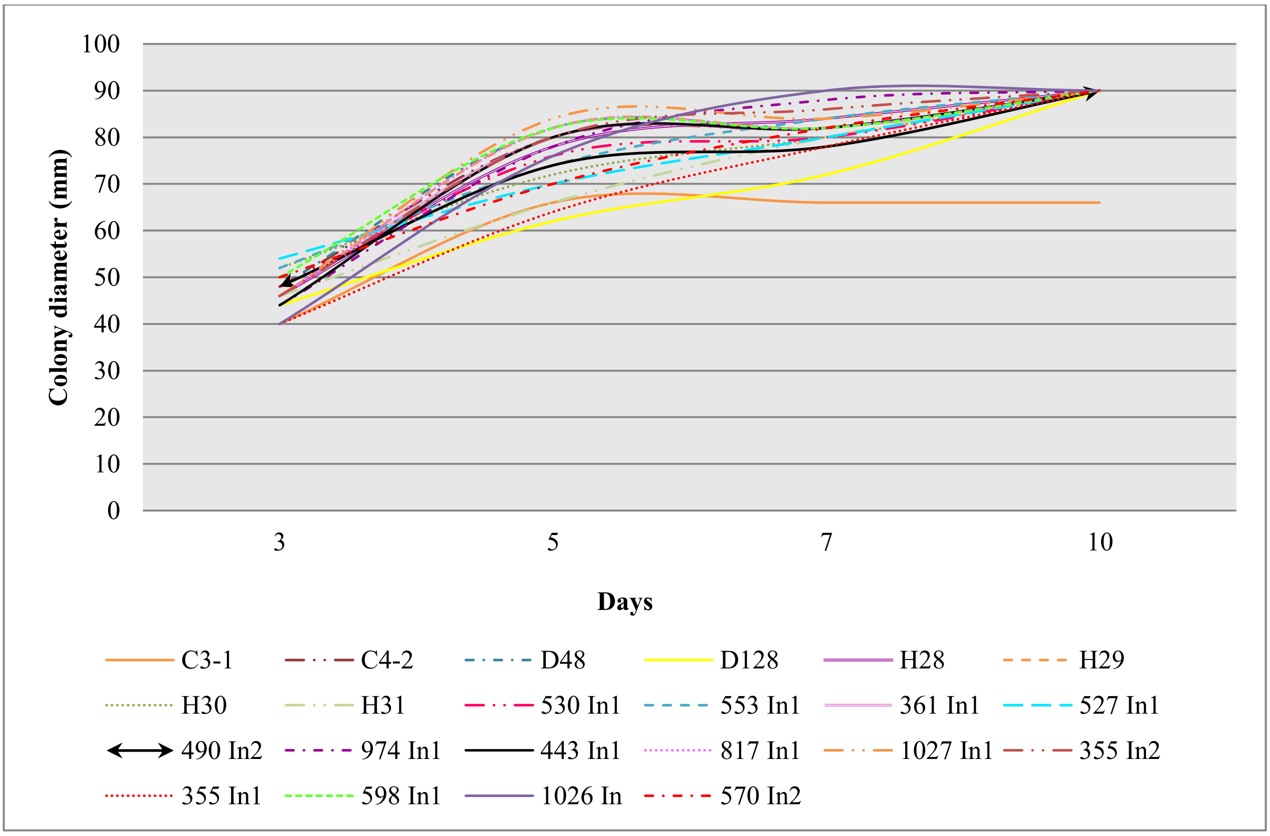


Figure 6-9. Growth rate of different strains grown on RV8.

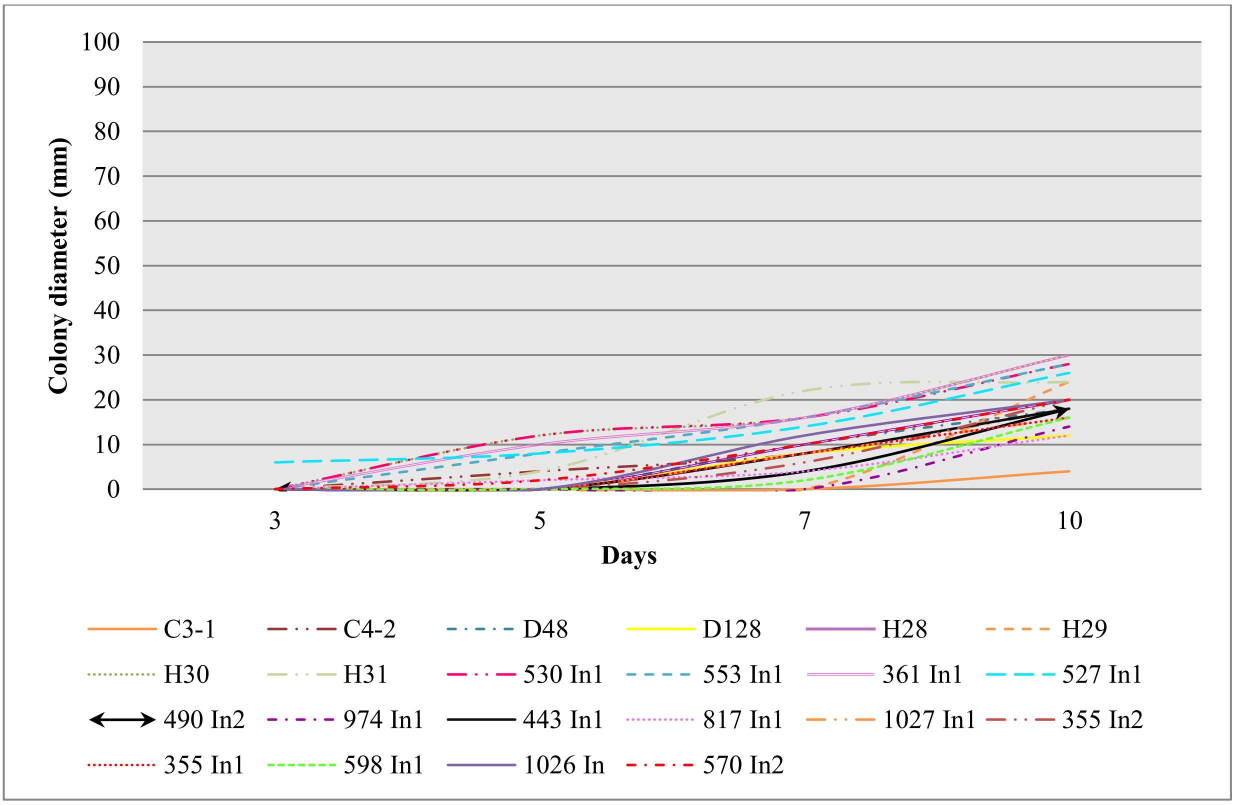


Figure 6-10. Growth rate of different strains grown on RA.

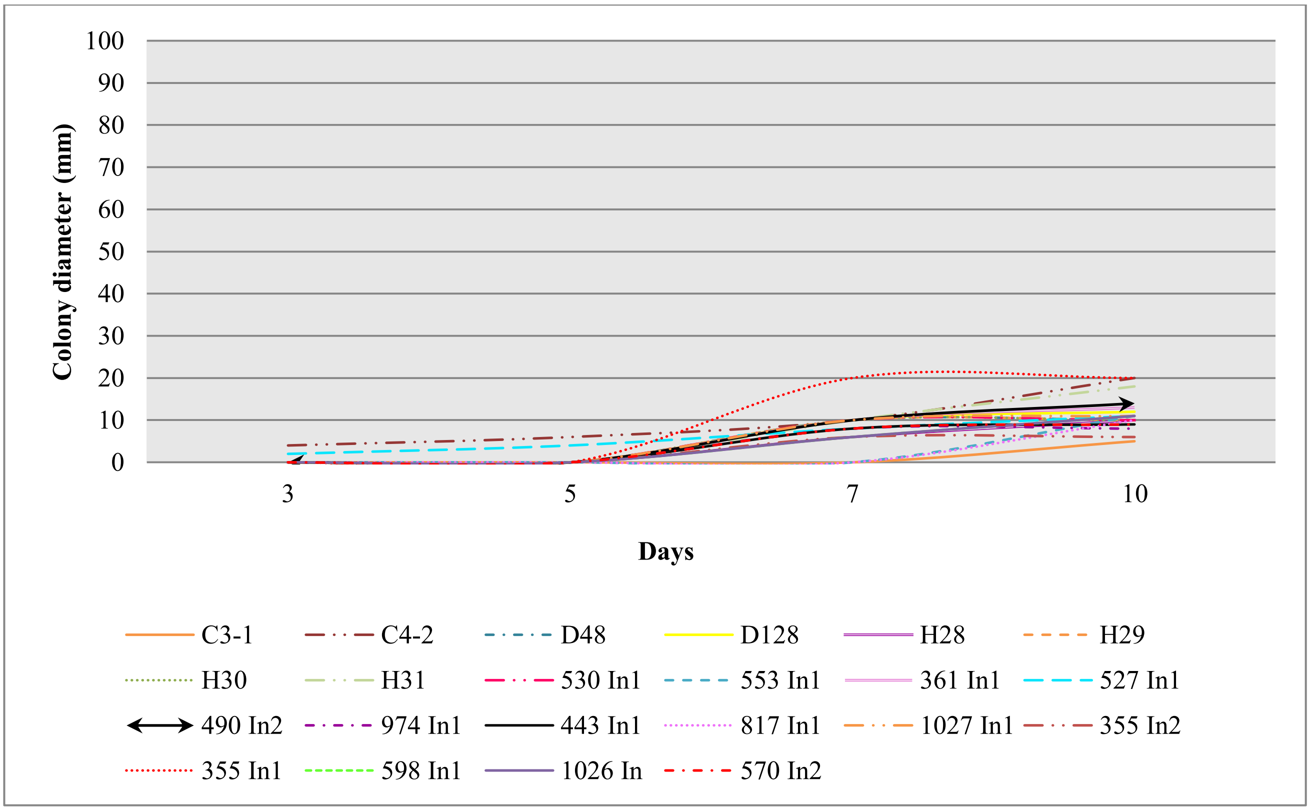


Figure 6-11. Growth rate of different strains grown on MRBA.

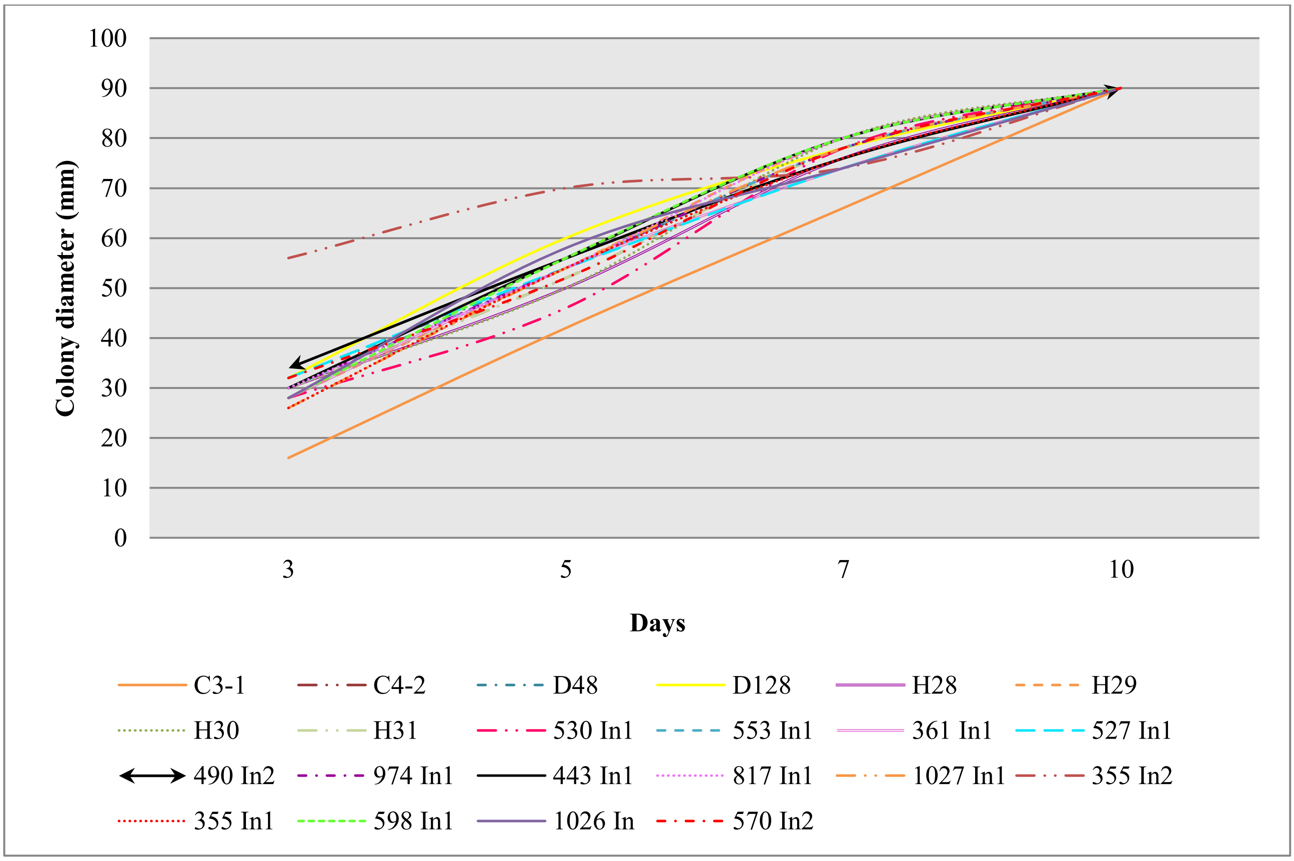


Figure 6-12. Growth rate of different strains grown on WA.

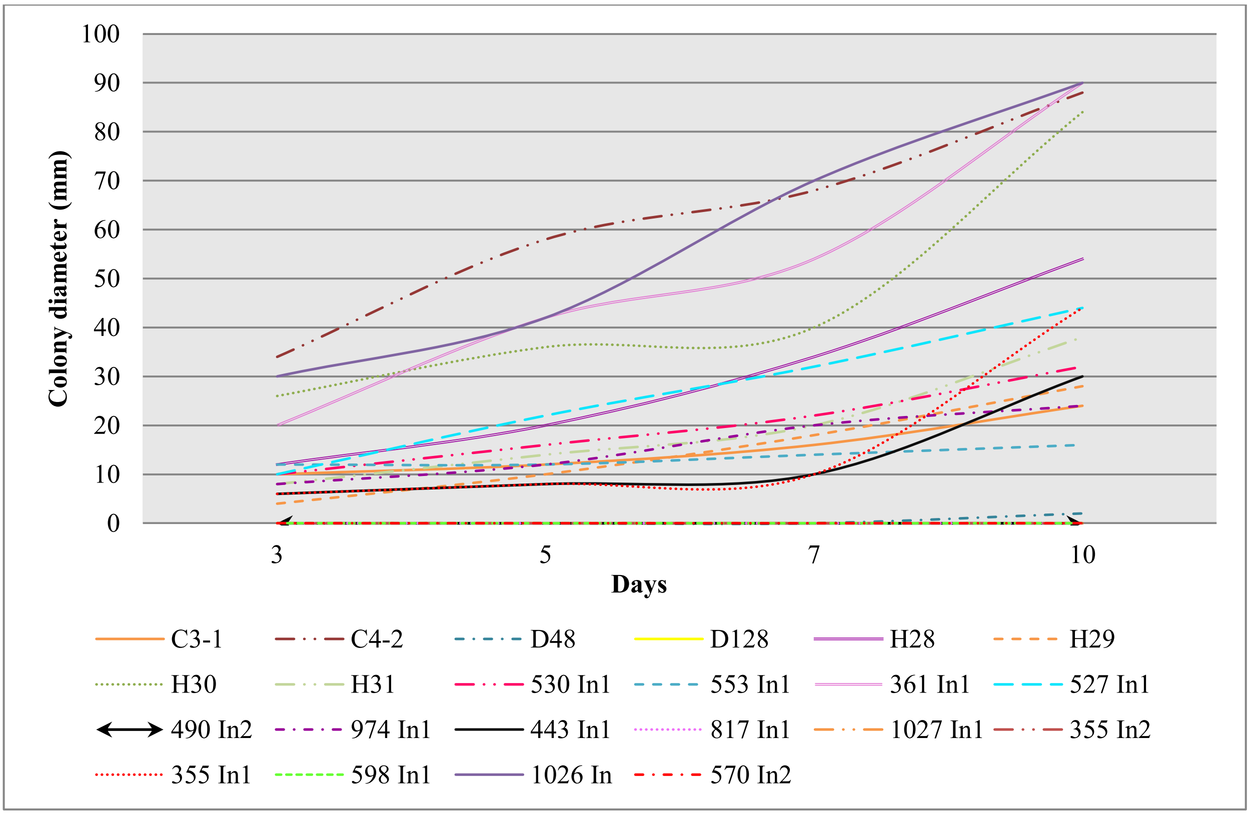


Figure 6-13. Growth rate of different strains grown on CLA.

6.3.3 Effect of pH on the growth

Effect of five different pH levels on the characteristics of strain colonies grown on PDA (table 6-9). Analyzing the average increase in diameter results summarized in figures: 6-14, 6-15, 6-16, 6-17 and 6-18; generally the level of optimal pH for all strains examined were mainly near alkaline pH level. All these strains showed started with difficulties to grow at low pH level. Strain C3-1 showed also in this experiment slower growth than the others. Images of colonies morphology of 22 strains grown at different pH level were shown in (Annex B from 17 to 21).

Table 6-9. Effect of five different pH levels on the characteristics of strain colonies grown on PDA and they were grouped by similarity.

pH	Day	Strain	Description of colonies	Aerial mycelium
4.5	7 and 10	H28, 1027 In 1, 1026 In		
		C3-1, D128, H29, H30, H31, 553 In1, 490 In 2, 974 In 1, 443 In 1, 817 In 1, 355 In1, 355 In 2, 598 In 1, 570 In 2,	Absence of acervuli ,with salmon color	White
		C4-2, D48, 530 In 1, 361 In 1, 527 In 1	Presence of few black acervuli,with red color	White
5.5	7 and 10	C4-2, H29, 1026 In, 1027 In 1		
		C3-1, H30, H31, 490 In 2, 355 In1, 598 In 1,	Absence of acervuli, white, with orange color near center	White
		C4-2, D48, D128, H29, 530 In 1, 553 In 1, 361 In 1, 527 In 1, 443 In1, 817 In1, 1027 In1, 355 In2, 1026 In , H28, 974 In1, 570 In2	Presence of few black acervuli, with orange color near center	White
6.5	7 and 10	H28, 1027 In 1, 1026 In		
		D128	Absence of acervuli, with orange color	White
		C4-2, D48, H29, H30, H31, 530 In 1, 553 In 1, 361 In 1, 527 In 1, 490 In 2, 443 In 1, 817 In 1, 1027 In 1, 355 In 1, 355 In 2, 598 In 1, 1026 In , C3-1, H28, 974 In 1, 570 In 2	Presence of black acervuli, with dark orange color	White
7.5	7 and 10	H28, 1027 In 1, 1026 In		
		C3-1, C4-2, D128, H29, H31, 974 In 1, 443 In 1, 355 In 2	Absence of acervuli, with orange color	White
		D48, H30, 530 In 1, 553 In 1, 361 In 1, 527 In 1, 490 In 2, 817 In 1, 355 In 1, 598 In 1, 570 In 2	Presence of black acervuli, with dark orange color	White
8.5	7 and 10	H28, 1027 In 1, 1026 In		
		C3-1, C4-2, D48 H29, H30, H31, 530 In 1, 527 In 1, 490 In 2, 598 In 1	Presence of black acervuli, with orange color	White
		D128, 553 In 1, 361 In 1, 974 In 1, 443 In 1, 817 In 1, 355 In 1, 355 In 2, 570 In 2	Presence of black acervuli, with dark orange color and orange exudate	White

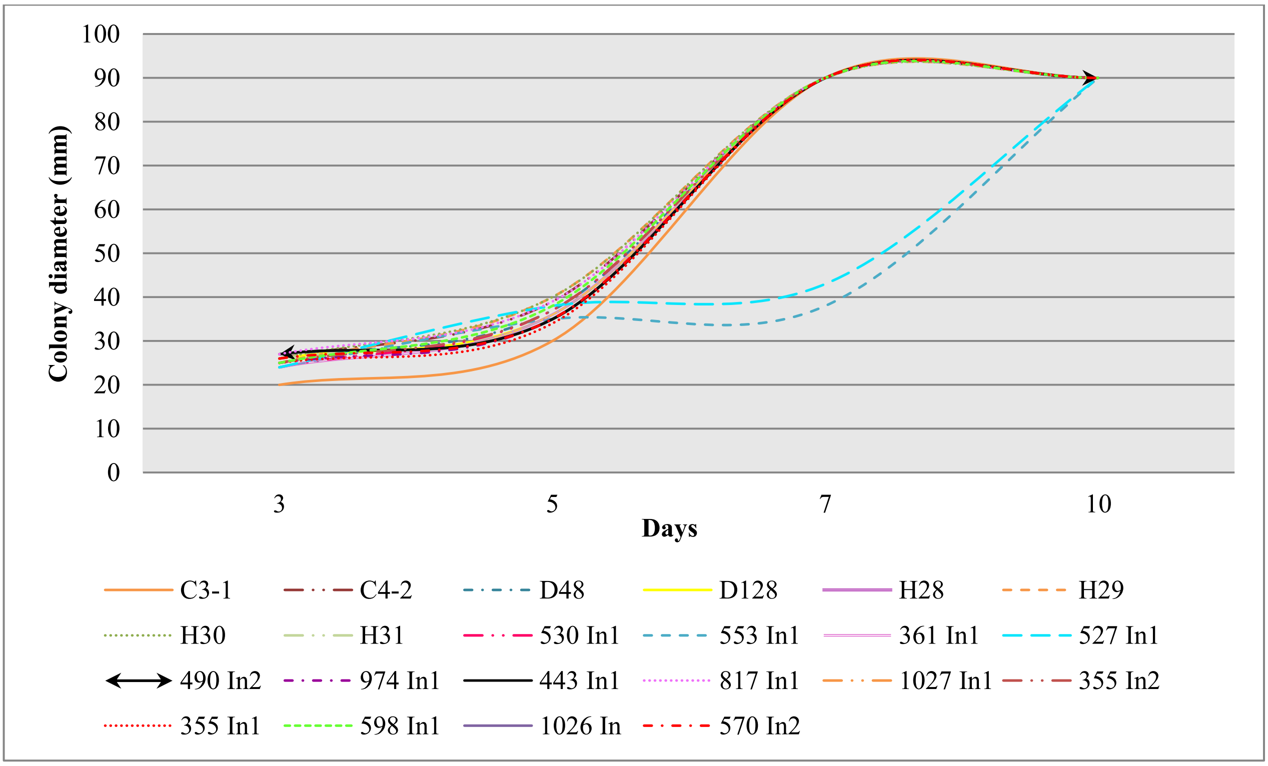


Figure 6-14. Growth rate of different strains grown on PDA at pH level 4.5.

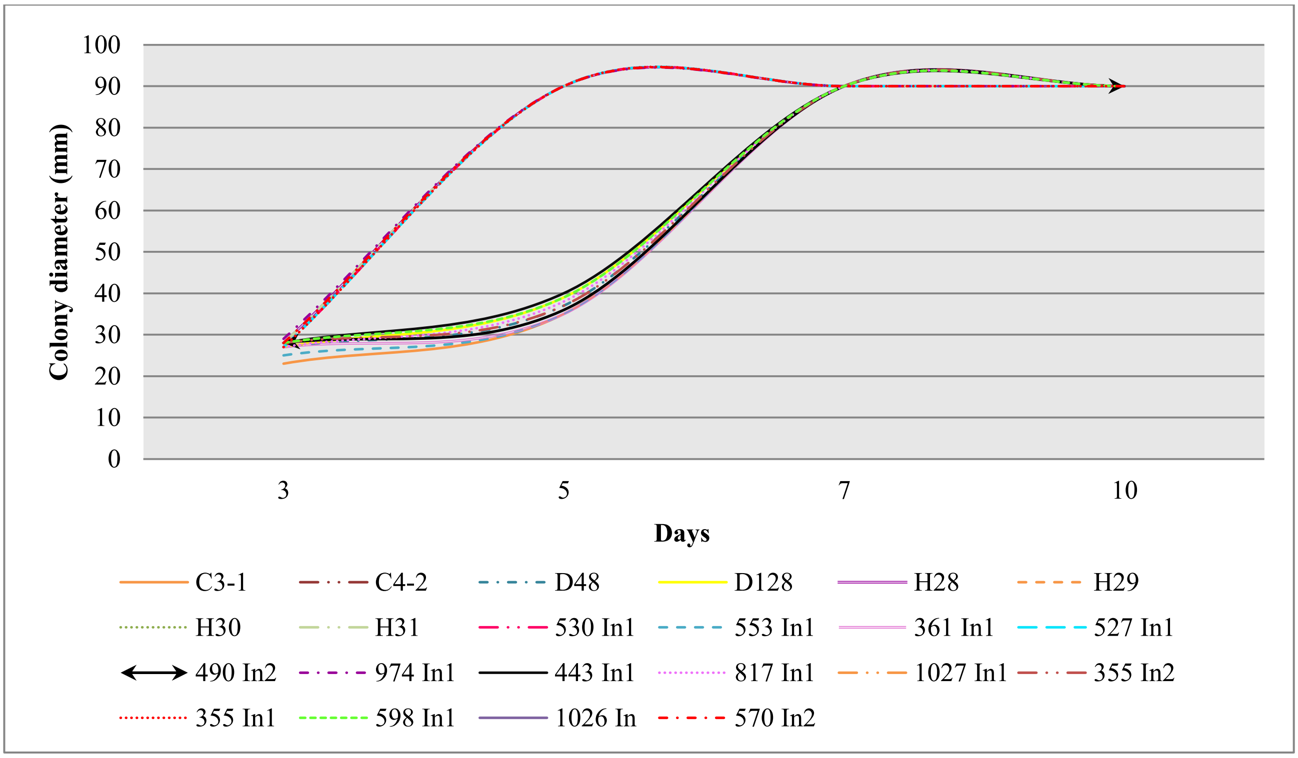


Figure 6-15. Growth rate of different strains grown on PDA at pH level 5.5.

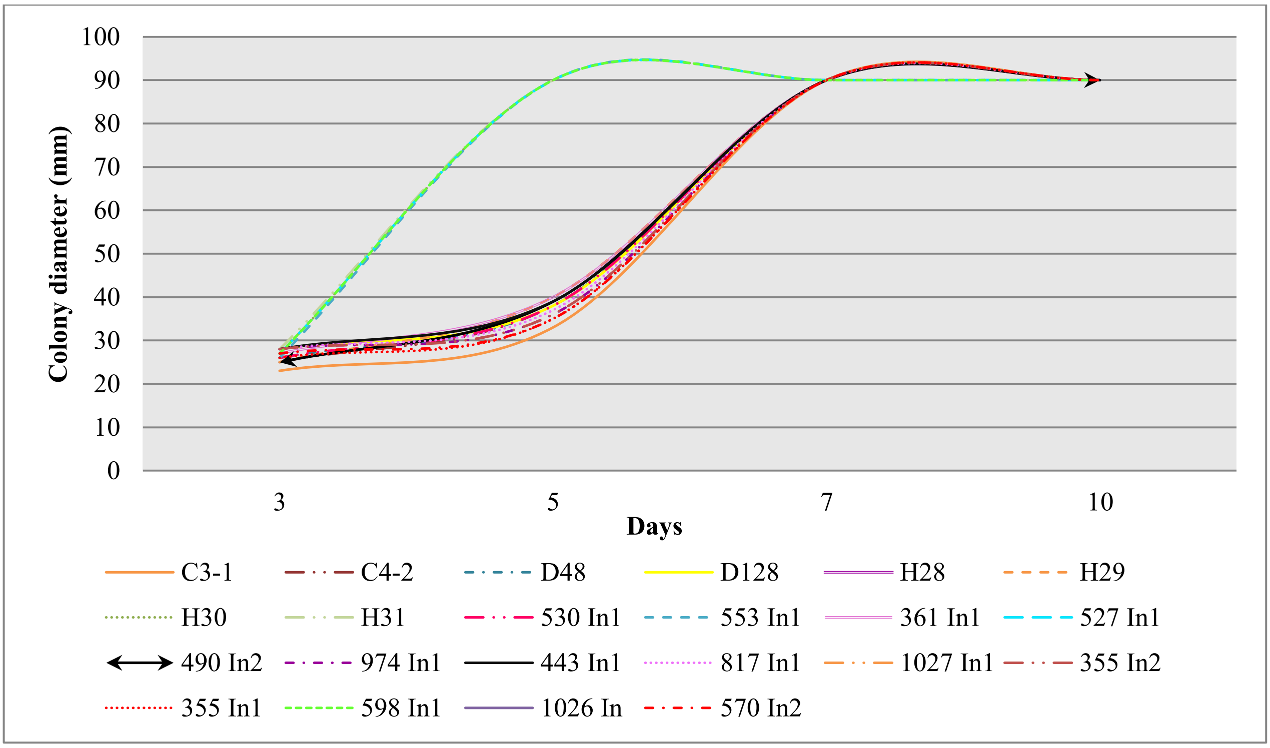


Figure 6-16. Growth rate of different strains grown on PDA at pH level 6.5.

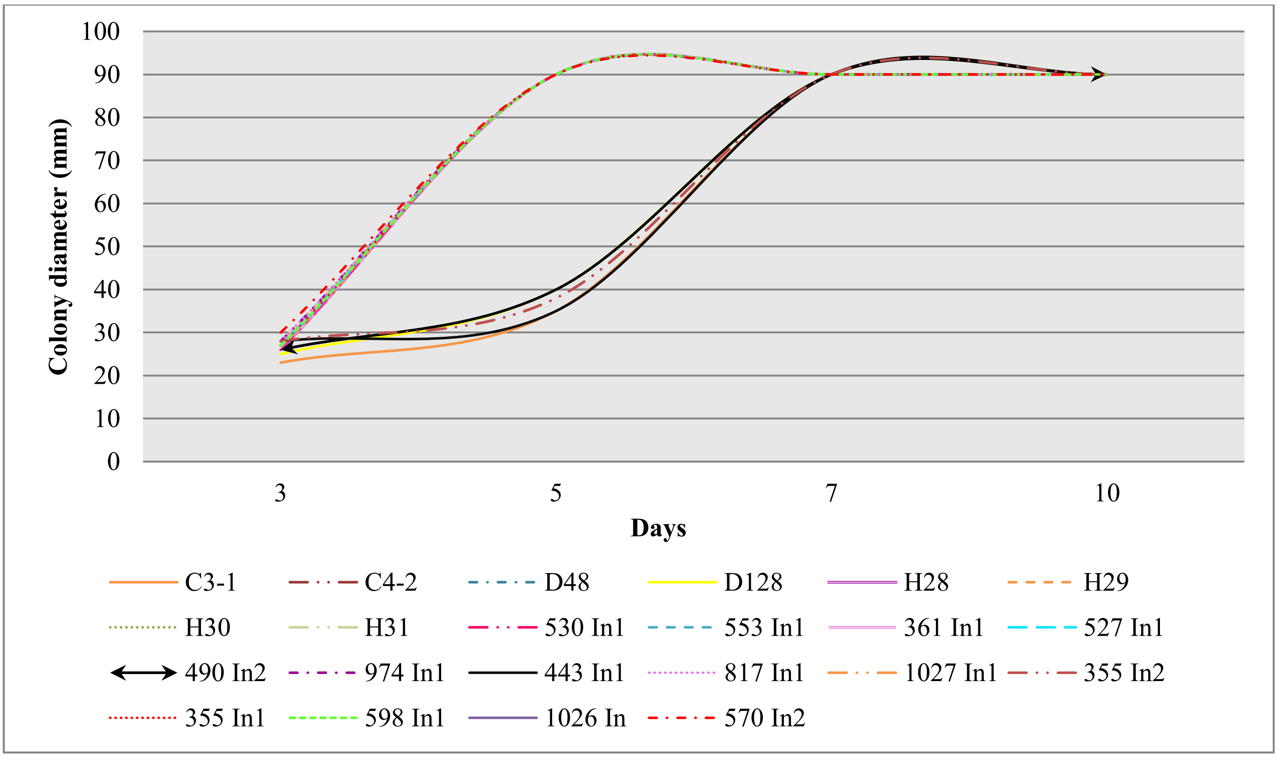


Figure 6-17. Growth rate of different strains grown on PDA at pH level 7.5.

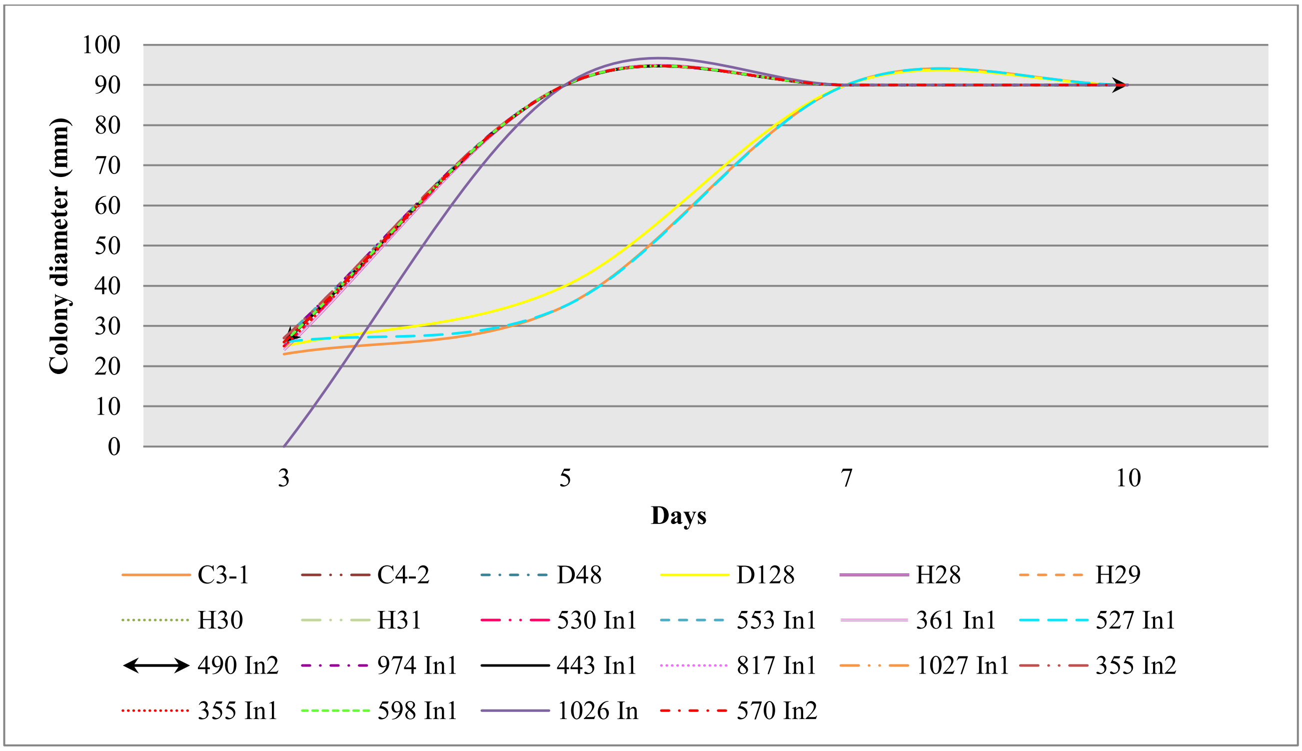


Figure 6-18. Growth rate of different strains grown on PDA at pH level 8.5.

6.3.4 Effect of different temperatures on the growth

Strain colonies were observed after incubation at: 5,10,15, 20, 25 and 30°C, on PDA (table 6-10). The data are reported and summarizzed in figures: 6-19, 6-20, 6-21, 6-22, 6-23 and 6-24. All strains showed the same average of growth rate that strongly slowed down at 5°C. Ten strains were able to colonies the entire plates at 15°C, while all others does not exceed the average growth diameter of approximately 35 mm. Started from 20°C, the increase in diameter was speed up to colonise the entire plates in seven days. Then was strongly accelerated at 25 and 30°C to colonise the entire plates even before the fifth day, to play the role as the best range of temperature for the growth of these strains. Also in this experiment, strain C3-1 showed a slower growth than the others. Images of colonies morphology of 22 strains grown at different temperature degrees were shown in (Annex B from 22 to 27).

Table 6-10. Effect of different temperatures on the characteristics of strain colonies grown on PDA and they were grouped by similarity.

Temperatures	Day	Strain	Description of colonies	Aerial mycelium
5°C	7 and 10	C4-2, D48, D128, H29, H30, H31, 530 In1, 553 In1, 361 In1, 527 In1, 490 In 2, 443 In1, 817 In1 , 1027 In1, 355 In1, 355 In2, 598 In 1, 1026 In , C3-1, H28, 974 In1, 570 In2	Absence of acervuli, with white colony from both front and back side	White
10°C	7 and 10	C4-2, D48, D128, H29, 553 In1, 361 In1, 527 In1, 490 In 2, 443 In1, 817 In1 , 1027 In1, 355 In1, 355 In2, 598 In1, 1026 In , C3-1, H28, 974 In1, 570 In2 H30, H31, 530 In1,	Absence of acervuli, with white colony from both front and back side	White
15°C	7	C4-2, D48, D128, H29, 553 In1, 361 In1, 527 In1, 490 In 2, 443 In1, 817 In1 , 1027 In1, 355 In1, 355 In2, 598 In 1, 1026 In , C3-1, H28, 974 In1, 570 In2, H31	Absence of acervuli, with cream color	White
		H30, 530 In1	Absence of acervuli, with orange exudate	White
	10	C4-2, D48, D128, H29, 553 In1, 361 In1, 527 In1, 490 In 2, 443 In1, 817 In1 , 1027 In1, 355 In2, 598 In 1, 1026 In , 974 In1, 570 In2,	Absence of acervuli, with cream color	White
		C3-1, H28, H30	Presence of black acervuli, with cream color	White
		H31, 530 In1, 355 In1	Presence of black acervuli, with orange exudate	White
20°C	7 and 10	C4-2, D48, D128, H29, H30, H31, 530 In1, 553 In1, 361 In1, 527 In1, 490 In 2, 443 In1, 817 In1 , 1027 In1, 355 In2, 598 In 1, 1026 In , H28, 974 In1, 570 In2	Presence of few black acervuli, with cream color and white colony from both front and back side	White
		C3-1, 355 In1	Presence of few black acervuli, with orange exudate, and back side of salmon color	White
25°C	7	C3-1	Orange color colony with acervuli that surround the plate edge	
		C4-2, H30, 490 In 2	Absence of acervuli, with orange color	White
		D48, 443 In 1, 361 In1, 553 In1, 530 In1, H31	Presence of few black acervuli, with orange color	White
		598 In 1 , 355 In1, 355 In2, 1027 In1 , 817 In1 , 974 In1 , 527 In1	Presence of few black acervuli, with dark orange color near center	White
	10	C3-1	Presence of more black acervuli	White
		974 In1	Presence of more black acervuli, with salmon color	White

		C4-2, D48, D128, H29, H30, H31, 530 In1, 553 In1, 361 In1, 527 In1, 490 In 2, 443 In1, 817 In1 , 1027 In1, 355 In1, 355 In2, 598 In 1, 1026 In , H28, 570 In2	Presence of more black acervuli, with cream color and white colony from both front and back side	White
30°C	7	C3-1, H30 , 530 In1, 355 In1, 355 In2, 598 In 1, 1026 In 1,	Absence of acervuli, with salmon color	White
		C4-2	Presence of some black acervuli, with salmon color	White
		D48, D128, H28 , H29, H31 , 361 In1, 1027 In1, 570 In 2, 490 In 2, 974 In1, 443 In1, 817 In1	Presence of some black acervuli near center, with salmon color	White
		553 In1, 527 In1	Presence of just one black acervuli near center, with salmon color	White
	10	C3-1, 530 In1, 355 In1, 355 In2, 1026 In	Absence of acervuli, with salmon color	White
		C4-2, H29, H30 , 974 In1,	Presence of some black acervuli, with salmon color	White
		D48, D128 , H28 ,H31, 361 In1, 490 In 2, 443 In1, 817 In1 , 1027 In1, 570 In2 ,	Presence of some black acervuli near center, with salmon color	White
		553 In1, 527 In1	Presence of just one black acervuli near center, with salmon color	White

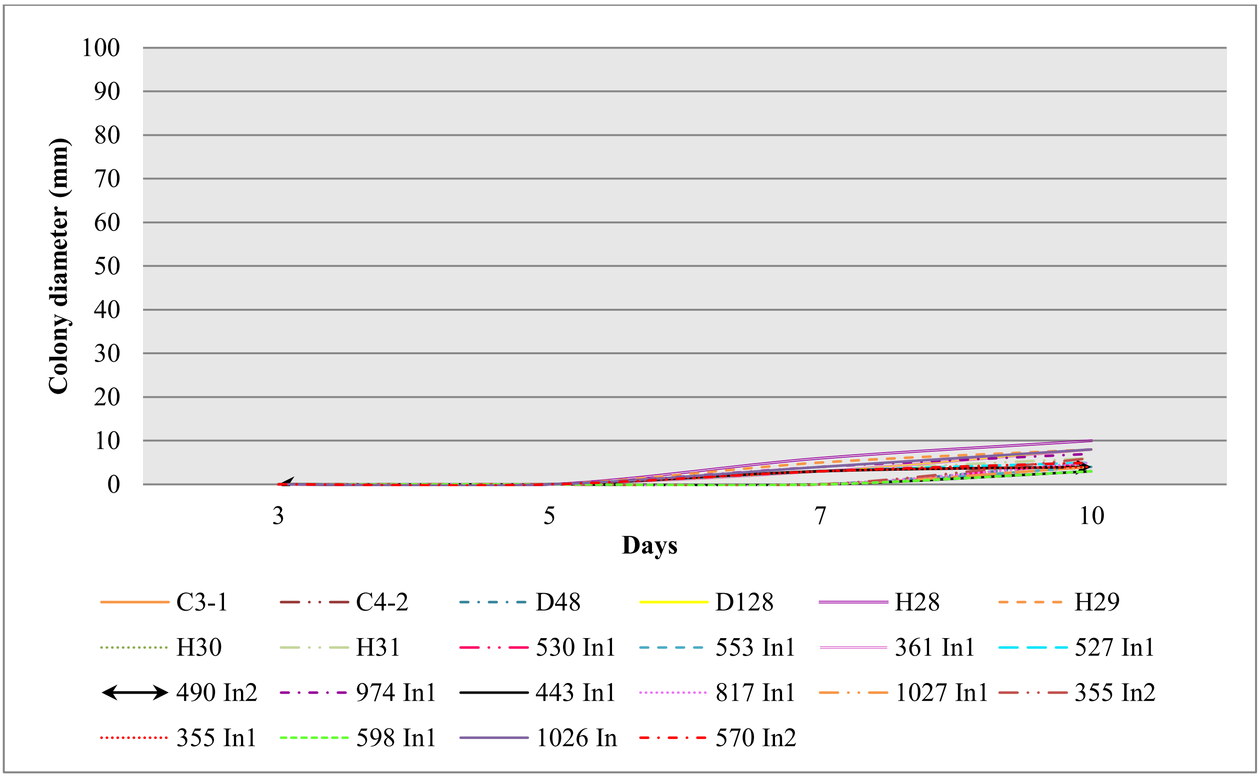


Figure 6-19. Growth rate of different strains grown on PDA at 5°C.

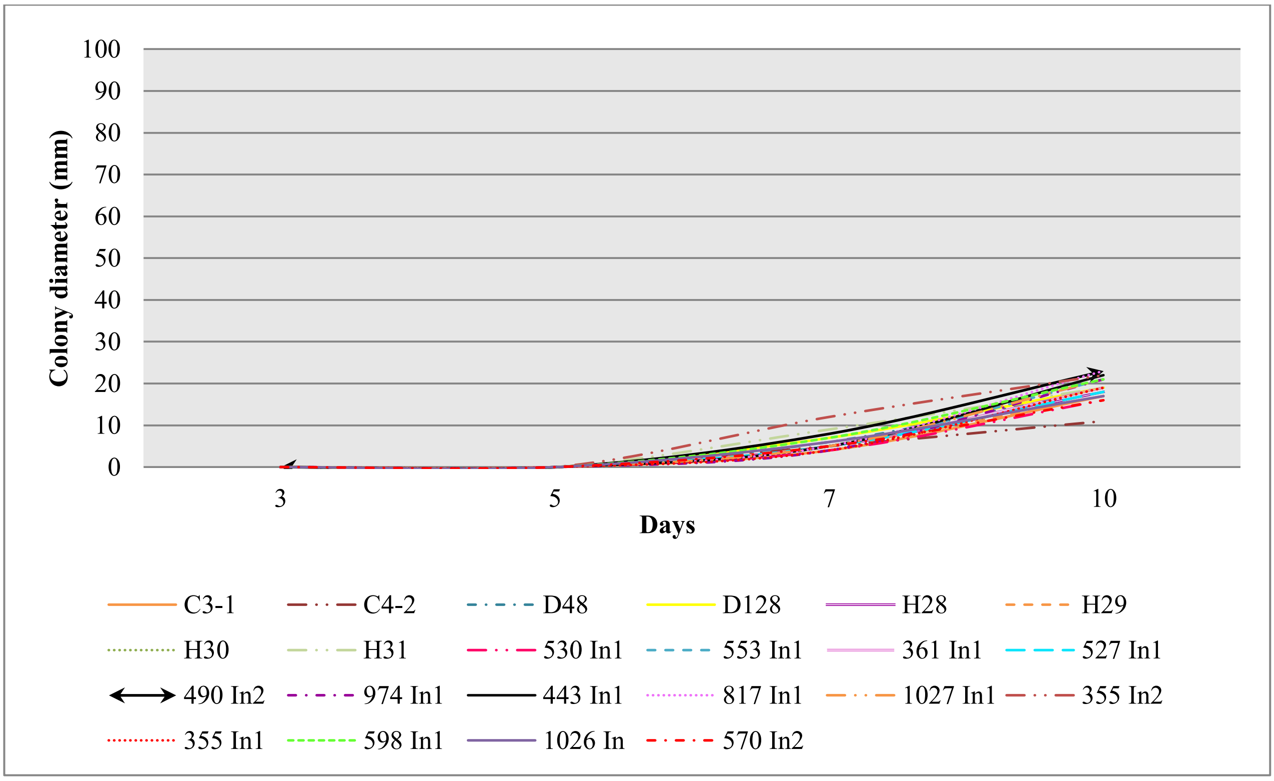


Figure 6-20. Growth rate of different strains grown on PDA at 10°C.

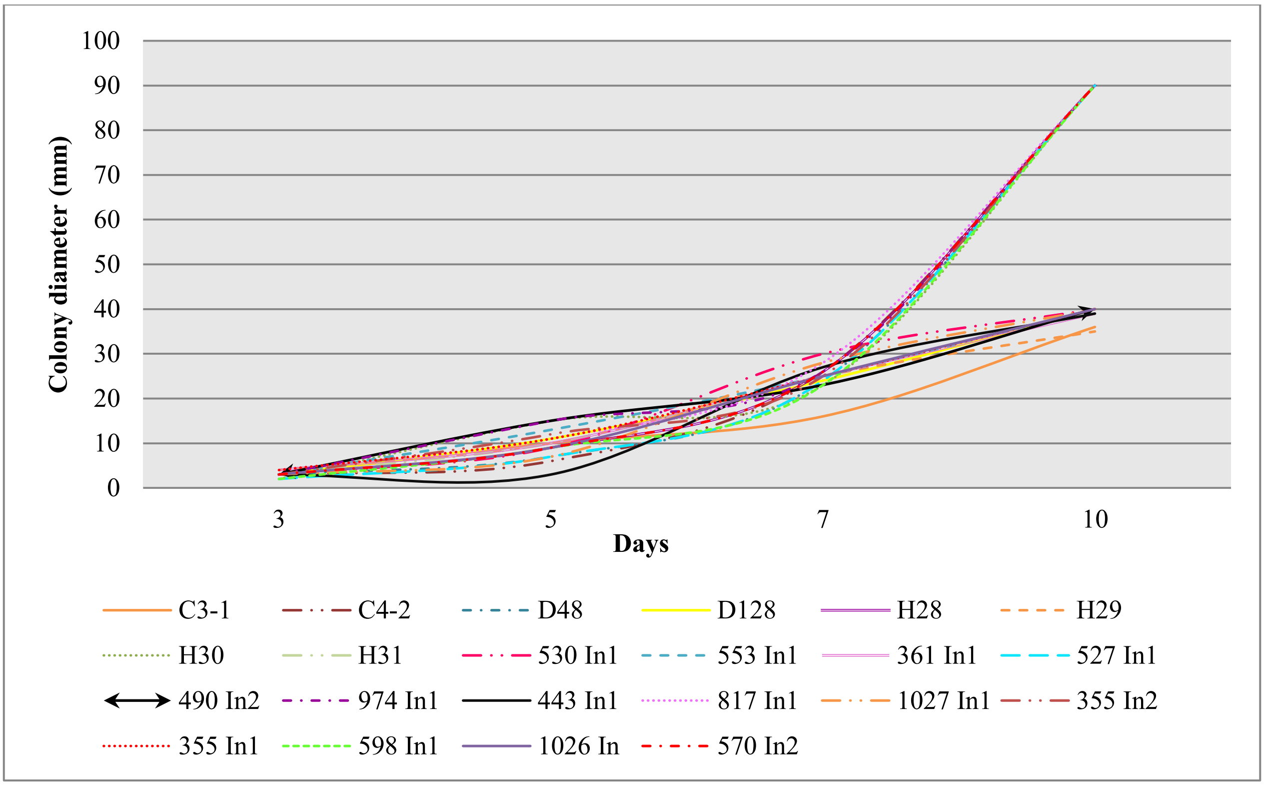


Figure 6-21. Growth rate of different strains grown on PDA at 15°C.

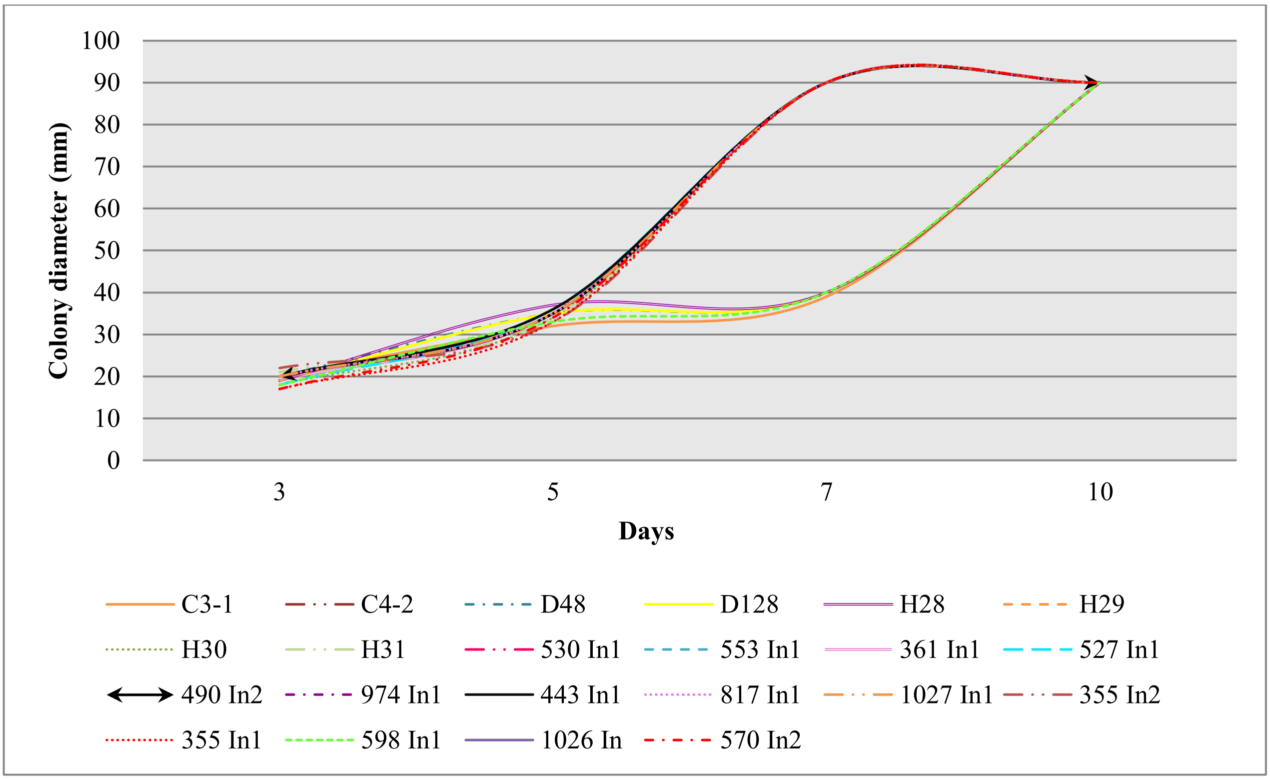


Figure 6-22. Growth rate of different strains grown on PDA at 15°C.

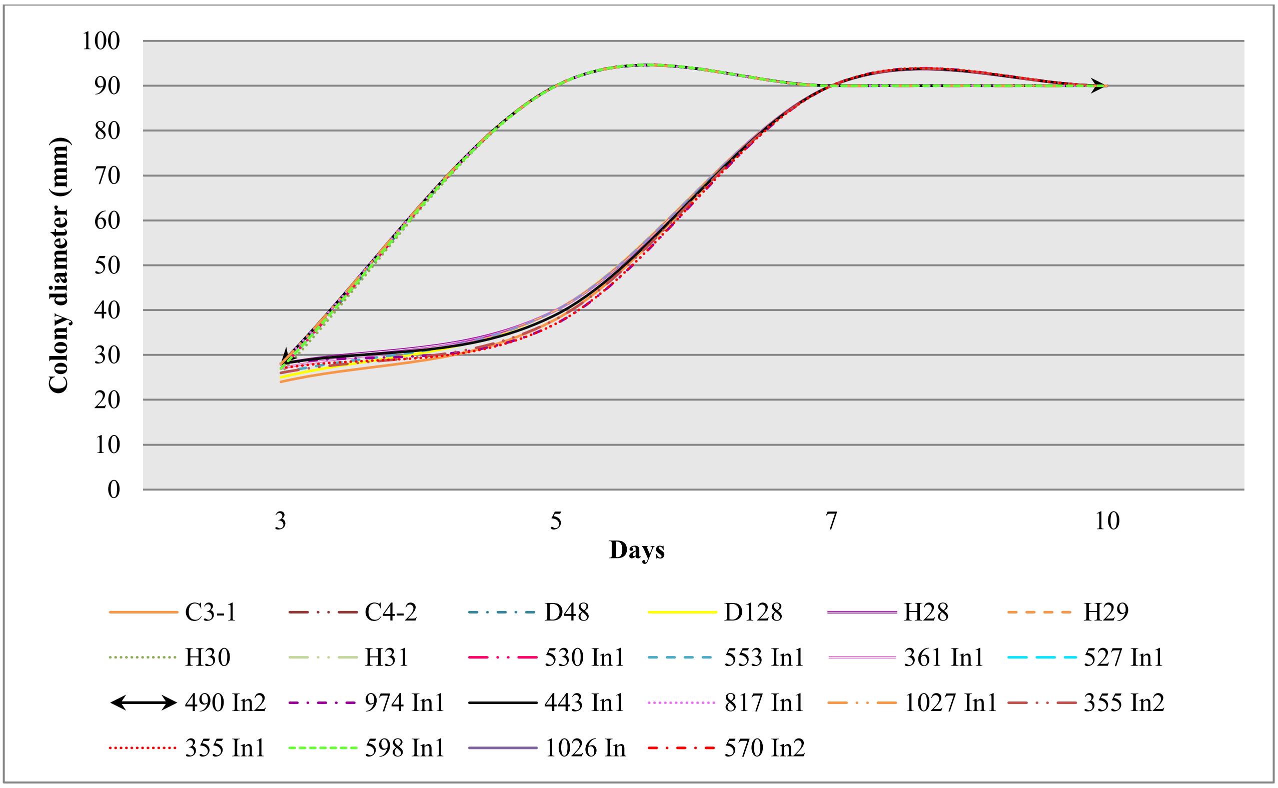


Figure 6-23. Growth rate of different strains grown on PDA at 25°C.

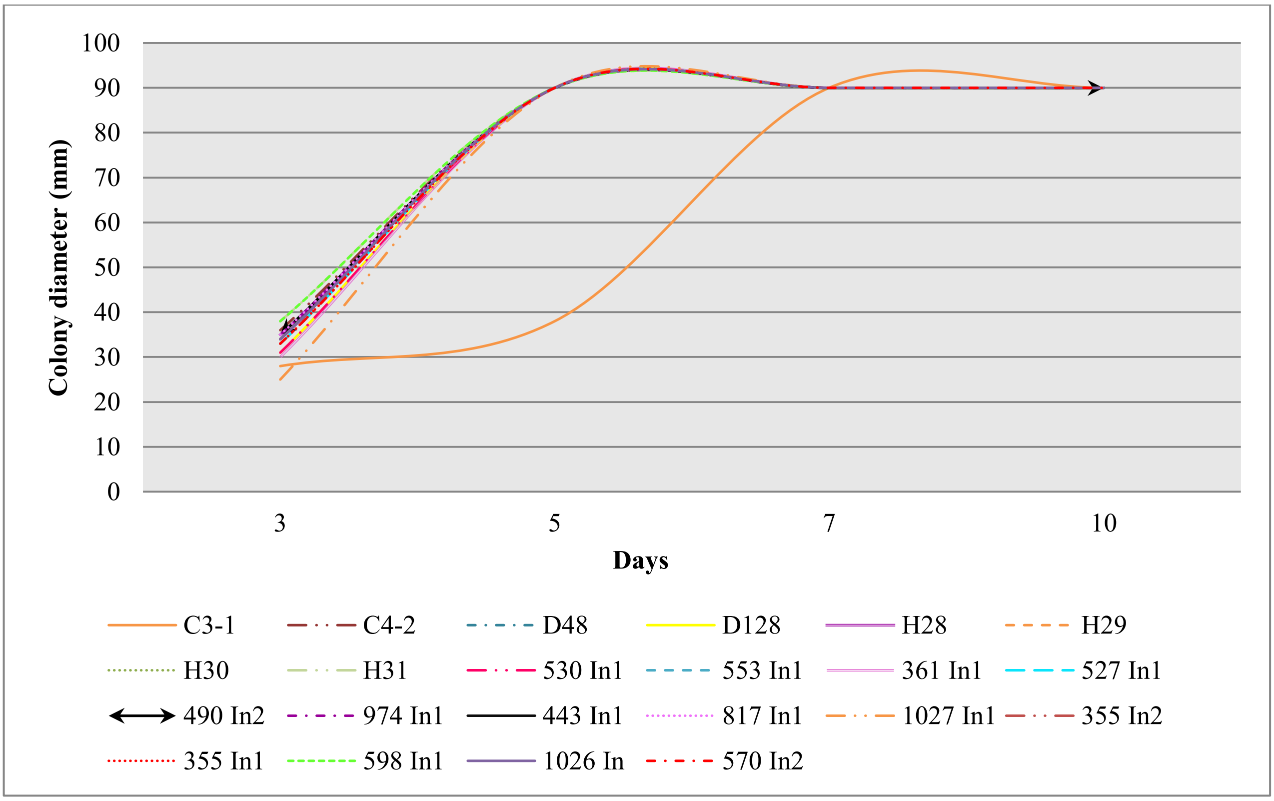


Figure 6-24. Growth rate of different strains grown on PDA at 30°C.

6.3.5 Using citrate and tartrate as a carbon source

Colonies were observed after 14 days of incubation at 24°C on medium B supplemented with citrate or tartrate as a carbon source. The positive results, when the bromocresol purple was change in color from yellow to produce a dark blue to purple, appeared in case of the use of citrate or tartrate as a carbon source (figures 6-25, 6-26 and 6-27).

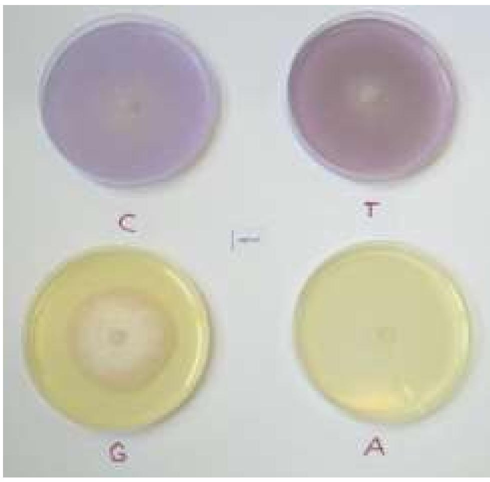


Figure 6-25. An example of the positive response: the use of citrate change pigment color to purple with mycelium growth (C), the use of tartrate changed to darker purple (T), the positive control with presence of glucose the pigment color remained yellow with mycelium growth (G), and the negative control without carbon sources remained yellow (A).

Figure 6-26. An example of the variability between strains in case of citrate with different level of positive response.

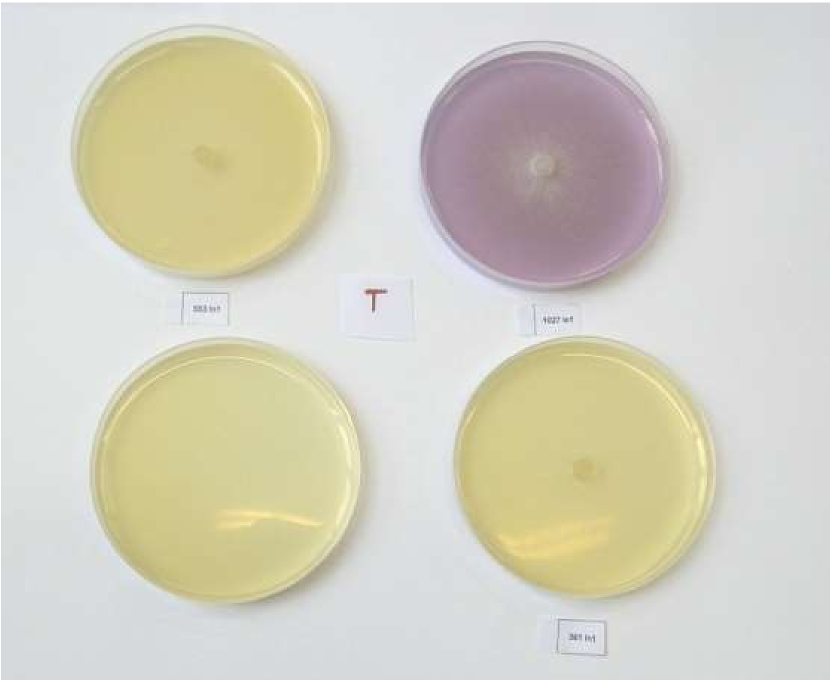


Figure 6-27. An example of the variability between strains in case of tartrate with only positive response we had using strain (1027 in1).

The characteristics considered were summarized in table 6-11, as well as the results of variability between strains in response to citrate or tartrate at different level. On the basis of visual observation we differentiate our strains depend on the intensity of purple color appears which indicate the utilizes of citrate as a carbon source, because we had only one strain (1027 in1) that showed positive response in case of tartrate.

Table 6-11. Use of citrate and tartrate as carbon source and description of the colonies.

Strain	Citrate		Tartrate		Positive control	Negative control
	Colony description	Utilization	Colony description	Utilization	Colony description	Colony description
C3-1	Transparent mycelium grow up to 30 mm diameter, with red to pink purple color	-	Transparent mycelium grow up to 30 mm diameter	-	Irregular white aerial mycelium colonized the entire surface	Transparent mycelium colonized the entire surface
C4-2	Transparent mycelium colonized the entire surface, with red to pink purple color	++	Transparent mycelium grow up to 30 mm diameter	-	Irregular white aerial mycelium	Transparent mycelium colonized the entire surface
D48	White aerial mycelium with purple pigment color, presence of black acervuli	++	Transparent mycelium grow up to 30 mm diameter	-	Irregular white aerial mycelium	Transparent mycelium colonized the entire surface
D128	White aerial mycelium with purple pigment color, with orange exudate	++	Transparent mycelium grow up to 30 mm diameter	-	Regular circle colony with white aerial mycelium	Transparent mycelium colonized the entire surface
H28	White aerial mycelium with purple pigment color near center	+	Transparent mycelium colonized the entire surface	-	Irregular white aerial compact mycelium	Transparent mycelium colonized the entire surface
H29	White aerial mycelium with purple pigment color, with orange exudate and presence of black acervuli	+	Transparent mycelium colonized the entire surface	-	Irregular white aerial compact mycelium	Transparent mycelium colonized the entire surface
H30	White aerial mycelium with purple pigment color, with orange exudate	+	Transparent mycelium colonized the entire surface	-	Regular circle white aerial compact mycelium	Transparent mycelium colonized the entire surface
H31	White aerial mycelium with purple pigment color, with orange exudate	+	Transparent mycelium colonized the entire surface	-	Regular circle white aerial compact mycelium	Transparent mycelium colonized the entire surface
530 In1	White aerial mycelium with purple pigment color	+	Transparent mycelium grow up to 30 mm diameter	-	Regular circle white aerial compact mycelium	Transparent mycelium colonized the entire surface
553 In1	White aerial mycelium with purple pigment color	+	Transparent mycelium grow up to 30 mm diameter	-	Regular circle white aerial compact mycelium	Transparent mycelium colonized the entire surface
361 In1	White aerial mycelium with purple pigment color	+	Transparent mycelium grow up to 30 mm diameter	-	Regular circle white aerial compact mycelium	Transparent mycelium colonized the entire surface
527 In1	White aerial mycelium with purple pigment color	++	Transparent mycelium grow up to 30 mm diameter	-	Regular circle white aerial compact mycelium	Transparent mycelium colonized the entire surface

490 In2	White aerial mycelium with purple pigment color	++	Transparent mycelium grow up to 30 mm diameter	-	Regular circle white aerial compact mycelium	Transparent mycelium colonized the entire surface
974 In1	White aerial mycelium with purple pigment color, with orange exudate and presence of black acervuli	+	Transparent mycelium colonized the entire surface	-	Regular circle white aerial compact mycelium	Transparent mycelium colonized the entire surface
443 In1	White aerial mycelium with purple pigment color	++	Transparent mycelium grow up to 30 mm diameter	-	Regular circle white aerial compact mycelium	Transparent mycelium colonized the entire surface
817 In1	White aerial mycelium with purple pigment color, and presence of black acervuli	++	Transparent mycelium grow up to 30 mm diameter	-	Regular circle white aerial compact mycelium	Transparent mycelium colonized the entire surface
1027 In1	White aerial mycelium	++	White aerial mycelium	++	Regular circle white aerial compact mycelium with dark purple color	Transparent mycelium colonized the entire surface
355 In2	White aerial mycelium, with presence of black acervuli	++	Transparent mycelium grow up to 30 mm diameter	-	Regular circle white aerial compact mycelium	Transparent mycelium colonized the entire surface
355 In1	White aerial mycelium	++	Transparent mycelium grow up to 30 mm diameter	-	Regular circle white aerial compact mycelium	Transparent mycelium colonized the entire surface
598 In1	White aerial mycelium	++	Transparent mycelium grow up to 30 mm diameter	-	Regular circle white aerial compact mycelium	Transparent mycelium colonized the entire surface
1026 In	White aerial mycelium	++	Transparent mycelium grow up to 30 mm diameter	-	Regular circle white aerial compact mycelium	Transparent mycelium colonized the entire surface
570 In2	White aerial mycelium with purple pigment color	++	Transparent mycelium grow up to 30 mm diameter	-	Regular circle white aerial compact mycelium	Transparent mycelium colonized the entire surface

Utilization level: ++ = strong utilization; + = utilization; - = no utilization

6.3.6 Identification based on molecular characterization

PCR amplification using the ITS has provided positive results for all representative strains considered, the PCR product varied in size from 500 to 700 nucleotides, and from 450 to 700 nucleotides in case of intergenic region of (apn2 and MAT1-2-1) genes. Results obtained from these means showed clearly that, our strains were belonging to *Colletotrichum musae* (table 6-12). Strain C2-1 was part of a group of isolates obtained through the isolation from symptomatic crown samples arrived with severe rot, and occasionally identified as *Colletotrichum* spp. using ITS, but later on we never had any isolate similar, then we excluded it from *Colletotrichum* group because it is not representative. The nucleotide sequences of all representatives strains were shown in (Annex A-1)

Table 6-12. Identification of representative Colletotrichum strains, based on ITS and ApMat sequences.

Code	ITS			ApMat		
	Identification	**similarity**	**Accession n° in NCBI**	**Identification**	**similarity**	**Accession n° in NCBI**
D128	*C. musae*	99%	AJ301904.1	Not present		
C3-1	*C. musae*	99%	DQ453982.1	*C. musae*	99%	KC790670.1
C4-2	*C. musae*	99%	DQ453982.1	Not present		
D48	*C. musae*	99%	DQ453986.1	Not present		
C2-1	*Colletotrichum* sp.	99%	HQ264183.1	*C. tropicale*	99%	JX145306.1
H30	Not present			*C. musae*	100%	JQ899268.1
H28	Not present			*C. musae*	98%	KC888926.1
355 in1	Not present			*C. musae*	100%	KC888926.1
361 in1	Not present			*C. musae*	99%	KC790670.1
974 in1	Not present			*C. musae*	100%	JQ899268.1

Furthermore, we performed the phylogenetic tree (figure 6-28) comparing our strains with selected sequences from published research or strains included in international collections which proves the validity of identification results obtained.

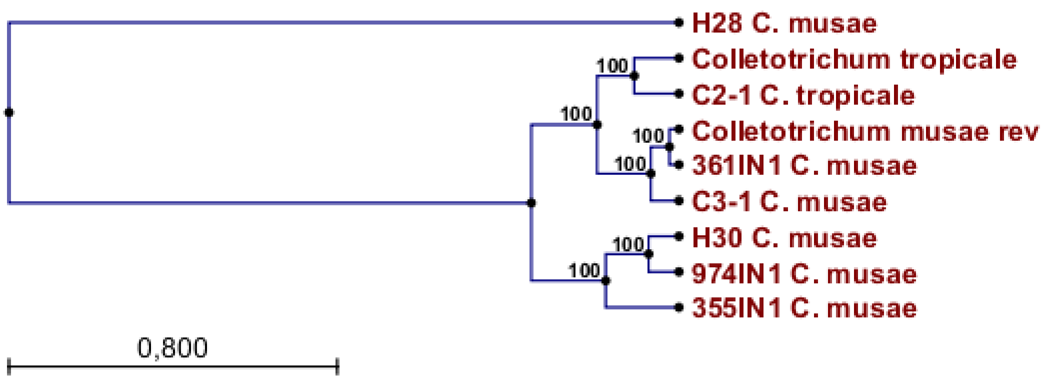


Figure 6-28. Phylogenetic relationships of Colletotrichum spp. sequences using the tree layout of UPGMA.

6.3.7 Variability based on amplifying the satellite regions

The evaluation of similarity between strains based on the genetic profile or genetic fingerprint, derived from the use of certain molecular markers with primers based on repeated sequences of mini- and micro-satellites. Strains were grouped on the basis of the presence or absence of various bands, but it showed clear affinity results between strains used (figures 6-29, 6-30, 6-31 and 6-32). These results are similar to those obtained from morphological tests, which showed in general few differences but not significant between strains of *C. musae* in our study.

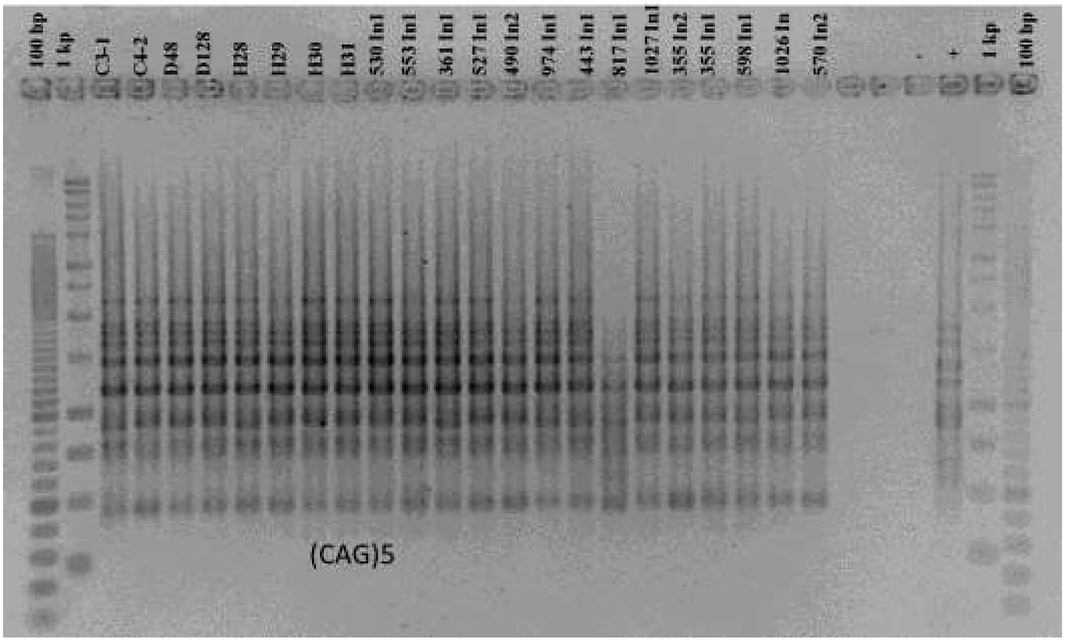


Figure 6-29. Electrophoretic gel image of amplification products obtained with (CAG)$_5$ primer.

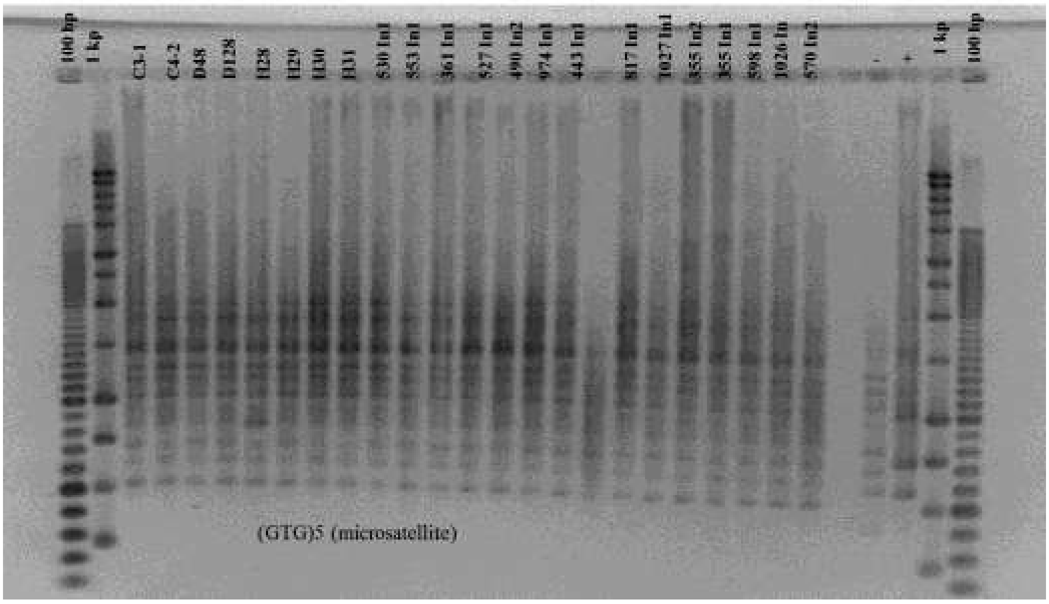


Figure 6-30. Electrophoretic gel image of amplification products obtained with (GTG)$_5$ primer.

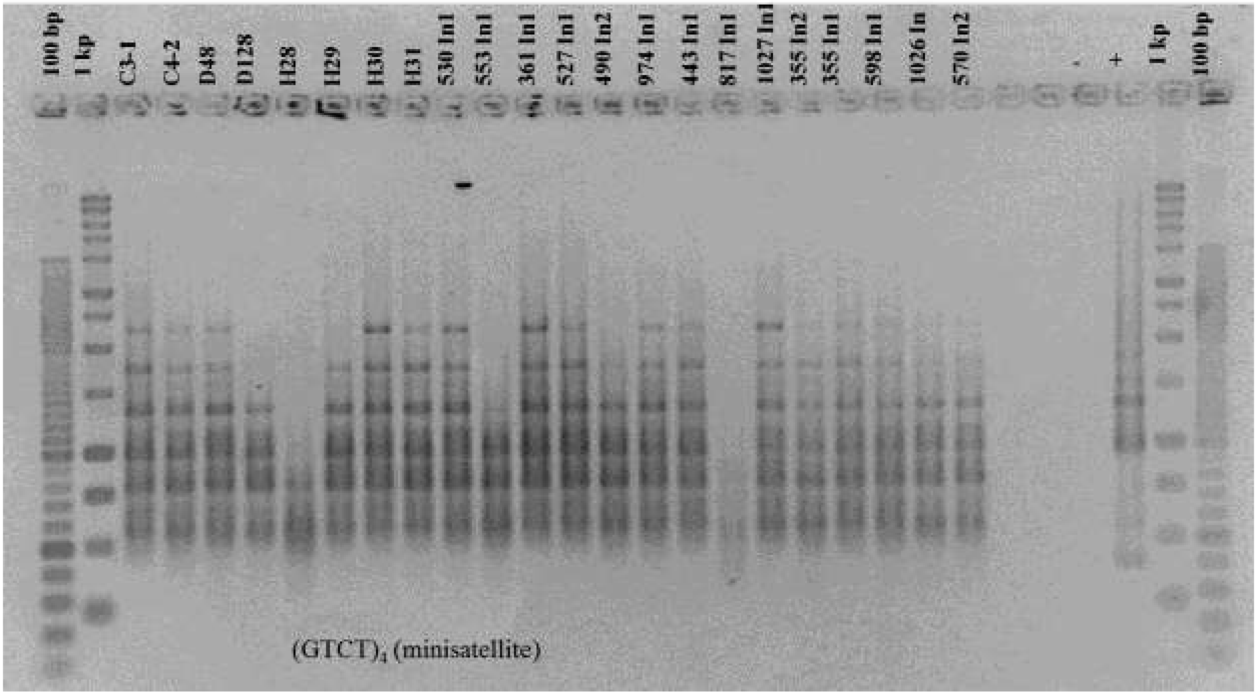


Figure 6-31. Electrophoretic gel image of amplification products obtained with (GTGC)$_4$ primer.

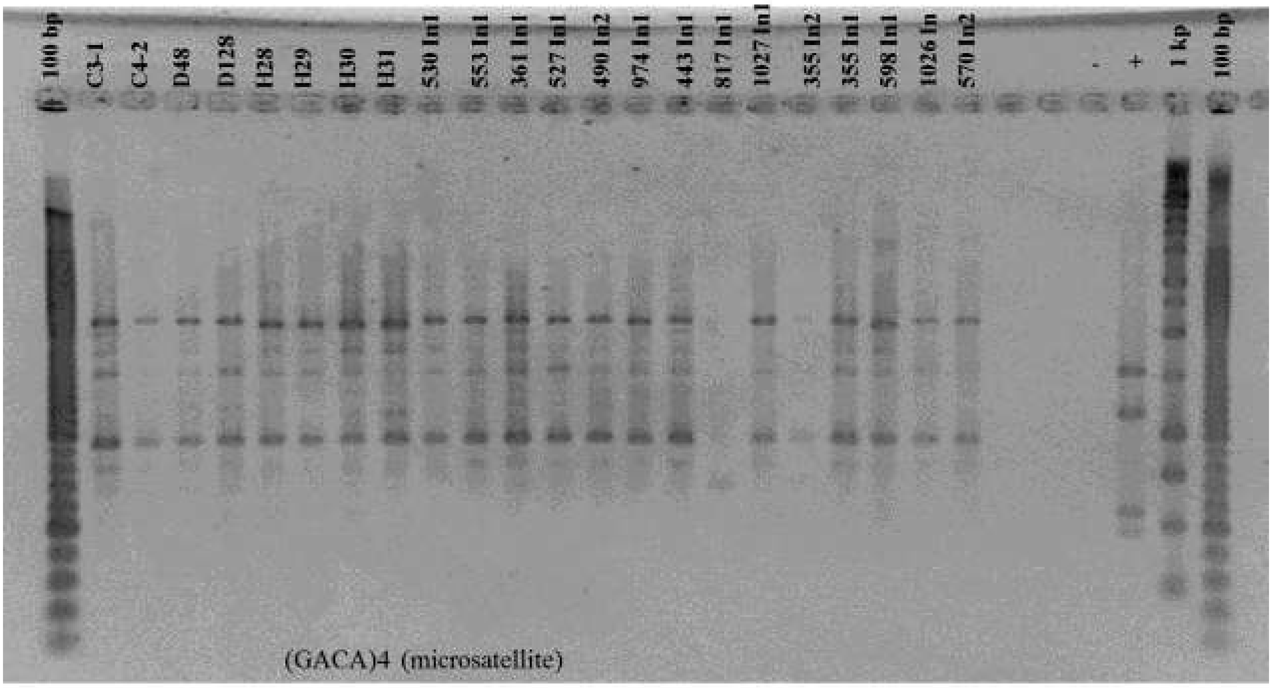


Figure 6-32. Electrophoretic gel image of amplification products obtained with (GACA)$_4$ primer.

7 Chapter Seven : Morphological and molecular characterization of strains belonging to genera: *Lasiodiplodia*, *Curvularia* and *Nigrospora* isolated from crown tissues of organic bananas.

7.1 Introduction

Lasiodiplodia (Botryosphaeriaceae) was described by Ellis and Everhart (1894), and *L. theobromae* is a plant pathogen with a very wide host range, including bananas, as it mostly prevalent in tropical and subtropical climate regions (Punithalingam, 1976). It causes rotting and dieback in most species, moreover is known as post harvest fungus disease (Úrbez-Torres *et al.*, 2008). It is common also as one of the most important pathogens that involved in crown rot disease as reported in Sri Lanka, where *L. theobromae* caused a fast spread of crown rot (Gunasinghe and Karunaratne, 2009); and in Dominican Republic as described in chapter two and three. All strains of the genus *Lasiodiplodia* obtained during this study, it were a sterile fungus mycelium without appearance of any of spores types. Then careful and clear studies on fungi involved, should be in consideration. The work in this chapter aimed to characterize some strains isolated fron crown tissues belonging to the genus *Lasiodiplodia*, as well as some other isolates having the same properties e.g. *Curvularia* and *Nigrospora*.

7.2 Materials and methods

7.2.1 Morphological identification

The study was conducted on 49 strains isolated from bananas as reported in chapter 2, and based on the colonies related to *Lsiodiplodia,* only on colony appearance they were grouped to be considered related to the genus *Lasiodiplodia* (table 7-1). Because, all these isolates did not produce spores and appeared as sterile mycelium.

Table 7-1. The origin of all isolates.

Code	Origin	Code	Origin
D75	Crown debris	D97	Crown debris
D76	Crown tissues	D98	Flowers
D88	Flowers	D99	Crown tissues taken at dehanding.
D89	Crown from field	H38	Crown tissues taken at dehanding.
D90	Crown from field	D18	Crown debris
D91	Crown from field	D50	Crown tissues taken after dehanding tank.
A12	Symptomatic crown tissues	D117	Crown from Boxes
A13	Symptomatic crown tissues	D120	Crown tissues taken after dehanding tank.
A05	Symptomatic crown tissues	D124	Flowers
D1025	Crown tissues	D126	Flowers
D255	Crown tissues taken after dehanding tank	D131	Crown tissues taken after dehanding tank.
D440	Internal crown tissues taken after packaging	D132	Crown from Boxes
D461	Crown tissues	D137	Flowers
D462	Crown tissues	D138	Crown tissues taken after Alum treatment.
D549	Outer layer crown tissues taken after packaging	D254	Crown from field
D66	Crown from field	D200	Crown tissues taken after dehanding tank.
D73	Crown from field	D201	Crown tissues taken after dehanding tank.
D74	Flowers	D232	Crown from field
D77	Crown tissues taken after dehanding tank	D236	Crown from field
D78	Crown tissues	D234	Crown from field
D79	Flowers	D239	Crown from field
D80	Crown tissues	D253	Crown from field
D81	Flowers	D277	Crown from field
D94	Crown tissues taken after Alum treatment	D263	Crown from field
D96	Crown tissues taken at dehanding.		

7.2.2 Molecular characterization

Same methods described in chapter two for DNA extractions was used, in additions, concentration of the total DNA extraction was quantified by fluorometer Qubit ™ kit and the Quant-iT ™ "dsDNA HS Assay Kit" (Invitrogen ™) according the instruction given by the producer, using three readings of DNA concentration. Then different primers were used for amplify some DNA regions by PCR:

- ITS1 and ITS4 to amplify ITS-1 - 5.8S - ITS-2 region.
- β-tubulin, for the region of β-tubulin gene.
- Produce a fingerprint based on PCR products obtained using primers designed on some nucleotidic repeated sequences (table 7.2).

Table 7-2. Sequences of primers used to amplify the satellite regions.

Primer	**Sequenza 5' → 3'**
M13 (minisatellite)	GAG GGT GGC GGT TCT
$(GACA)_4$ (microsatellite)	GAC AGA CAG ACA GAC A
$(GTG)_5$ (microsatellite)	GTG GTG GTG GTG GTG

PCR based on primer designed on minisatellites and microsatellites were carried out using the reagent mixtures reported in tables 7-3, 7-4 (Thanos *et al.*, 1996; Alves *et al.*, 2007).

Table 7-3. Preparation of 30 µl PCR reaction for minisatellites primers used.

	Concentration				**µl for one sample**	**unit**
	stock	**unit**	**reaction**	**unit**		
GO TAQ	5	U/µl	0,9	U	0,18	µl
BUFFER	5	x	1	x	6	µl
DNTP mix	2,5	mM	0,2	mM	2,4	µl
$MgCl_2$	25	mM	3	µM	3,6	µl
Primer	50	µM	0,5	µM	0,3	µl
DD water					16,32	µl
DNA					1,2	µl

Table 7-4. Preparation of 30 µl PCR reaction for microsatellites primers used.

	Concentration				**µl for one sample**	**unit**
	stock	**unit**	**reaction**	**unit**		
GO TAQ	5	U/µl	0,9	U	0,18	µl
BUFFER	5	x	1	x	6	µl
DNTP mix	2,5	mM	0,2	mM	2,4	µl
$MgCl_2$	25	mM	3	µM	3,6	µl
Primer	50	µM	0,2	µM	0,12	µl
DD water					16,5	µl
DNA					1,2	µl

The amplification program was common for both mini- and microsatellites primers, with initial cycle of denaturation at 95°C for 5 min, 32 cycles of denaturation at 95°C for 15 sec, annealing at 50°C for 30 sec, extension at 72°C for 1.20 min, and final extension at 72°C for 6 min. Electoforesis were carried out as previously described in chapter 2, for 5 hours in a longer cell at 80 volts. The phylogenetic analysis done following methods described in chapter 5.

Data of individual bands were recorded as; 1= band present and 0= band absent, and then reprocessed with NTSYSpc 2.01 program. Matrices of similarity have been calculated using the Jaccard coefficient, which considers only the presence of a joint character as an indication of similarity. Strains were grouped on the basis of the presence or absence of various bands by cluster analysis. From this matrix, the dendrograms were obtained according to the method of UPGMA.

7.2.3 Results and discussions

Based on colonies characteristics on PDA and MEA, it was possible to group all strains into 13 morphological groups (table 7-5). Morphological groups A, B and C, have similar characteristics, as they produce on PDA colonies with cotton-like compacted mycelium, gray color darker in older partes. On MEA the gray aerial mycelium is less compacted, fluffy and tends to flatten in older areas. The back side of colonies is always gray, but much clearer in both groups B and C; all strains in this groups were characterized by rapid growth colonizing the entire plates surface within 2 days (table 7-6). In case of groups D and E, strains showed gray mycelium with rapid growth. On PDA the aerial mycelium was compacted with light gray color on both sides, sometimes darker on the back one and margin. On MEA the aerial mycelium is reduced with light gray almost flattened in centre. One strain was present in E group with irregular margin and more compact mycelium showed with some sectors visible on the back side. Identical gray colonies under group F with velvet surface on both media considered. The back side shows darker color near center. Four strains were present in group G but they are not identical because of differences in intensity of color. On PDA, light gray to beige cotton-like or velvet mycelium, and darker margin. These isolates produced reddish pigment in back side. On MEA growth is quite similar to PDA, but the pigment is yellow-brown color. The group H includes three strains with gray mycelium on both PDA and MEA with smooth texture except strain D120 with cotton-like mycelium, also the back side showed darker gray. In case of groups I, J, and K including two strains each as well as L and M with only one strain each. They had various colonies type, but all with gray color on PDA in both sides, and darker color on MEA. The mycelium texture is cotton-like with regular margins. Strains D124 and D263 are forming the morphological group J, with very dark gray-black color in both sides, and smooth texture. Group K showed on PDA very light gray color, almost white that is darker near center. Smooth surface without visible pigment. On MEA the fungus produces whitish aerial mycelium. Group L has one strain with light gray mycelium on both media, started with slow growth then reaches entier plate surface within the 5th day of incubation. Group M include only strain D126. The mycelium is very dark gray, and the growth is velvet. The variations was clearly appeared difference between strains growth, by measuring the diameters average after 2 days of incubation at 24°C (figure 7-1).

Table 7-5. Morphological appearance of colonies grown on PDA and MEA at 24°C for 5 days.

Code	Morphological group	PDA		MEA	
		Front	Back side	Front	Back side
D97	**A**				
A13	**B**				
D66	**C**				
D89	D				
D88	**E**				
D117	**F**				

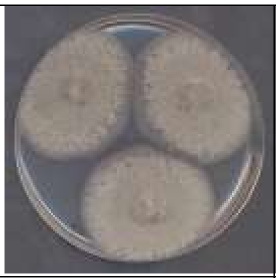
D200	**G**				
D277	**H**				
D18	**I**				
D124	**J**				
D137	**K**				
D50	**L**				
D126	**M**				

Table 7-6. Diameter average of strains grown on PDA at 24°C for 5 days, and their related morphological group.

Code	2 days	5 days	Morphological group	Code	2 days	5 days	Morphological group
D74	90	90	A	D88	61	90	E
D81	90	90	A	D117	17	37	F
D94	81	90	A	D131	15	34	F
D96	83	90	A	D232	24	60	F
D97	69	90	A	D253	17	41	F
D98	64	90	A	D254	18	40	F
D99	80	90	A	D200	19	45	G
A5	90	90	B	D132	27	60	G
A12	76	90	B	D239	19	47	G
A13	90	90	B	D236	29	66	G
D73	82	90	B	D120	24	33	H
D77	84	90	B	D201	13	16	H
D78	90	90	B	D277	11	21	H
D79	58	90	B	D18	49	90	I
D80	90	90	B	D234	75	90	I
D66	90	90	C	D124	21	51	J
D255	79	90	C	D263	17	42	J
D89	90	90	D	D137	31	77	K
D75	66	90	D	D138	74	90	K
D76	90	90	D	D50	26	90	L
D90	90	90	D	D126	28	82	M
D91	89	90	D				

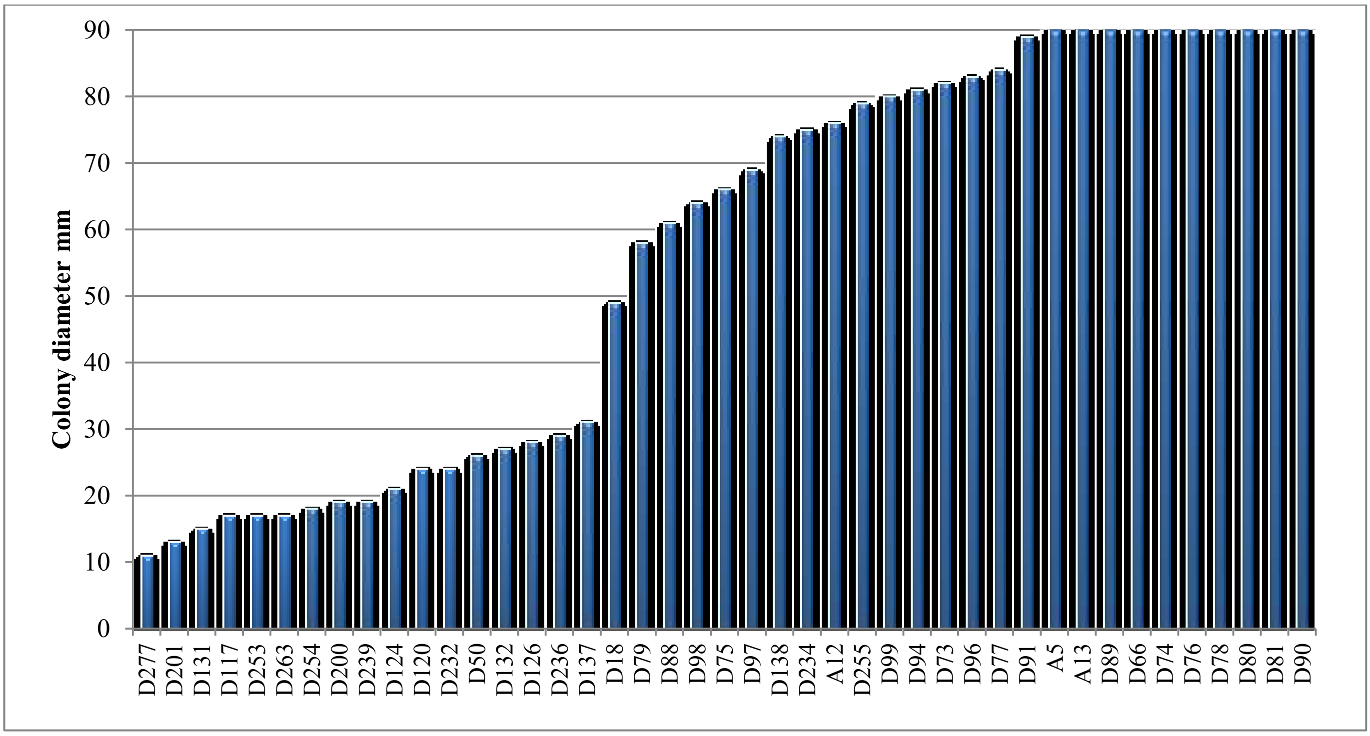


Figure 7-1. Diameter average of strains grown on PDA at 24°C for 2 days.

7.2.4 Identification based on molecular characterization

The quality of extracted DNA was determined and the concentrations were vary, then all suspensions of DNA were brought to a concentration equal to 5 µg/ml (table 7-7).

Table 7-7. Concentration of DNA extracted from strains.

Code	DNA µg/ml	Code	DNA µg/ml
A05	54.2	D97	49.9
A12	66.2	D98	1.89
A13	130.3	D99	121.3
D89	216	D117	19.7
D18	54.43	D120	6.7
D50	311.6	D124	1.71
D66	342	D126	6.04
D73	164.6	D131	11.8
D74	202	D132	4.35
D75	57.7	D137	14.7
D76	338	D200	36.8
D77	17.5	D201	10.35
D78	27.8	D232	15
D79	58.2	D234	131.3
D80	17,4	D236	4.87
D81	24	D239	11.5
D88	128.3	D253	0.76
D90	339.3	D254	18.3
D91	72.8	D255	271
D94	117.3	D263	32.6
D96	111.6	D277	0.73

PCR amplification of DNA regions ITS, β-tubulin and GPDEF as described in chapter 2, has provided positive results. The nucleotide sequences of all representatives strains were shown in (Annex A-1). By comparing the obtained sequences with published ones or other included in the international collections we coud identified our stains at the species level (table 7-8).

Table 7-8. Strains identification based on ITS, β-tubulin and GPDEF sequences.

Code	Primer	Identification	similarity	Accession n° in NCBI
D75	ITS	*L. pseudotheobromae*	100%	AB873040.1
	BT2		99%	KF254943.1
D76	ITS	*L. pseudotheobromae*	99%	JX914479.1
	BT2		99%	KP308523.1
D88	ITS	*L. pseudotheobromae*	100%	AB873041.1
D89	ITS	*L. pseudotheobromae*	100%	FJ904838.1
	BT2		100%	KM510360.1
D90	ITS	*L. pseudotheobromae*	100%	JX464075.1
	BT2		99%	KP308523.1
D91	ITS	*L. pseudotheobromae*	100%	JX464092.1
	BT2		99%	KP308523.1
A12	ITS	*L. theobromae*	99%	JX945583.1
	BT2		100%	KP721699.1

A13	ITS	*L. theobromae*	99%	JX868613.1
A05	ITS	*L. theobromae*	99%	JX275790.1
D255	ITS	*L. theobromae*	99%	JQ344356.1
	BT2		99%	KP721700.1
D66	ITS	*L. theobromae*	100%	KJ381073.1
	BT2		99%	KP721700.1
D73	ITS	*L. theobromae*	99%	JX275790.1
D74	ITS	*L. theobromae*	99%	JX275790.1
	BT2		100%	KP721699.1
D77	ITS	*L. theobromae*	100%	KJ381073.1
	BT2		100%	KP721699.1
D78	ITS	*L. theobromae*	100%	KJ381073.1
D79	ITS	*L. theobromae*	99%	JX275790.1
D80	ITS	*L. theobromae*	100%	KJ381073.1
	BT2		99%	KP721699.1
D81	ITS	*L. theobromae*	99%	HM346880.2
D94	ITS	*L. theobromae*	100%	JX275790.1
D96	ITS	*L. theobromae*	100%	JX275790.1
D97	ITS	*L. theobromae*	99%	KJ381073.1
D98	ITS	*L. theobromae*	99%	KJ381073.1
D99	ITS	*L. theobromae*	99%	KJ381073.1
D18	ITS	*Botryotinia fuckeliana*	99%	KF532975.1
D50	ITS	*Diaporthe phaseolorum*	77%	KF697689.1
D117	BT2	*Fusarium incarnatum*	99%	KJ020861.1
D124	ITS	*Curvularia hawaiiensis*	100%	KC999918.1
	GpDef	*Curvularia dactyloctenii*	99%	KJ415401.1
D126	ITS	*Exserohilum rostratum*	100%	FJ949084.1
D131	BT2	*Penicillium* sp.	100%	KP691061.1
D132	BT2	*Phoma sorghina*	100%	FJ427183.1
D137	ITS	*Fusarium solani*	99%	KC341961.1
D254	ITS	*Microsphaeropsis arundinis*	99%	JQ344356.1
D200	ITS	*Corynespora cassiicola*	99%	KF928288.1
D232	BT2	*Phoma sorghina*	100%	FJ427175.1
D236	BT2	*Phoma sorghina*	99%	FJ427182.1
D234	BT2	*Verticillium dahliae*	95%	XM_009651338.1
D239	BT2	*Fusarium incarnatum*	99%	KJ020861.1
D253	BT2	*Fusarium incarnatum*	99%	KJ020861.1
D277	BT2	*Fusarium incarnatum*	99%	KJ020861.1
D263	BT2	*Phoma* sp.	94%	JN130386.1
D235	ITS	*Sordariomycetes*	97%	JQ761140.1
F41	GpDef	*Curvularia aeria*	99%	HF565451.1
D135	GpDef	*Curvularia hawaiiensis*	100%	HG779142.1
F22	ITS	*Pestalotiopsis* sp.	99%	GU723442.1
	BT2		99%	KJ623200.1
F14	BT2	*Pestalotiopsis* sp.	95%	KC247155.1
F37	BT2	*Pestalotiopsis* sp.	93%	JX399043.1
D100	ITS	*Nigrospora* sp.	99%	JN207248.1
F35	ITS	*Nigrospora* sp.	99%	JN207298.1
D134	ITS	*Phoma* sp.	99%	HQ630963.1

Furthermore, we performed the phylogenetic tree (figures 7-2, 7-3) comparing our strains with selected sequences from published research or included in international collections which proves the validity of identification results obtained.

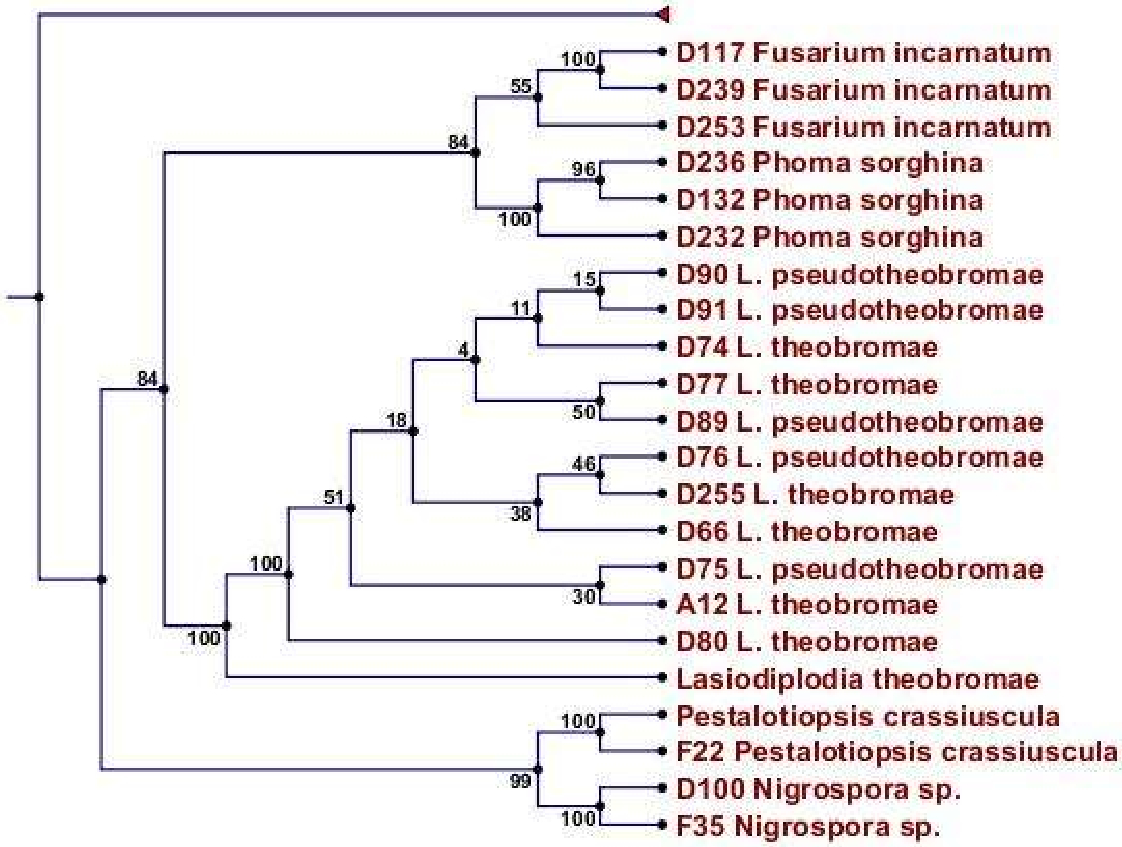


Figure 7-2. Phylogenetic relationships between strains based on their partial DNA sequences of BT2. Tree layout based on UPGMA.

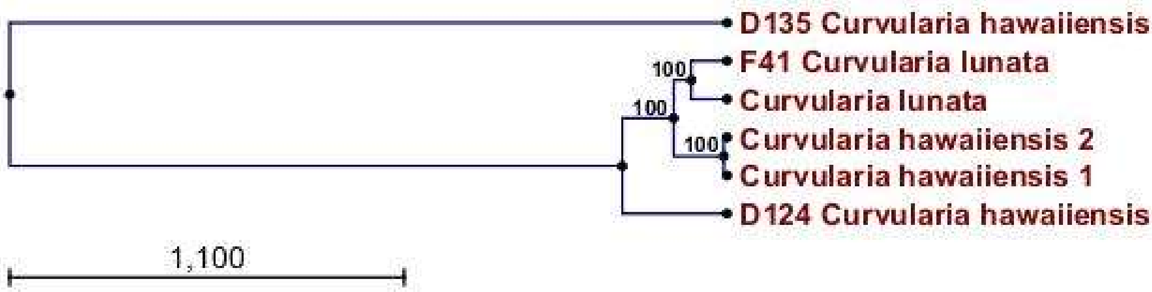


Figure 7-3. Phylogenetic relationships between Curvularia strains based on their partial DNA sequences of GpDef. Tree layout based on UPGMA.

7.2.5 Strain variability assessed by PCR amplification

The study on fungal population related to banana crown tissues revealed the presece of two species belonging the genus *Lasiodiplodia*: *L. theobromae* and *L. pseudotheobromae*. In order to differentiate between these strains, the evaluation of the genetic profile using primers based on repeated sequences of mini- and micro-satellites in order to assess their variability. Electrophoresis result of each amplicon obtained with primer M13 (figure 7-4), led to identification of 24 polymorphic bands ranging in size between 450 and 15800 bp (table7-9). The dendrogram shown in figure 7-5 shows the formation of three separate groups, in which 20 strains showed the same electrophoretic profile, and were placed in one group. Furthermore, all strains of *L. pseudotheobromae* have given the similarity in the genetic fingerprinting profile except strain D89.

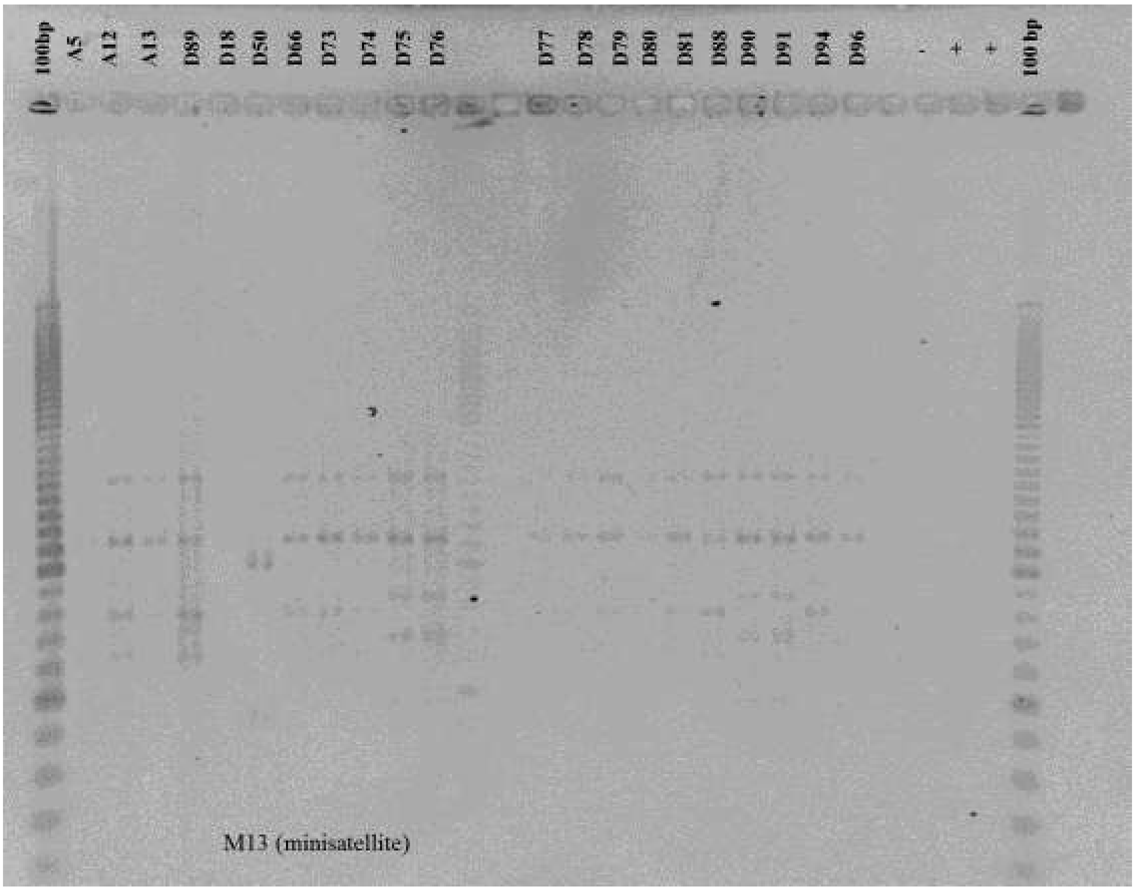


Figure 7-4. Electrophoretic gel image of amplification products obtained with M13 primer.

Table 7-9. Matrix relative to the electrophoretic profile obtained by M13 primer.

	Band size (bp)																						
Code	450	493	502	574	640-649	664	677	720-722	745	798-799	800	805-814	816-824	879-882	1030	1064	1147-1149	1158-1163	1170-1178	1183-1184	1542	1550-1552	1563-1567	1580
A5	0	0	0	0	1	0	0	0	0	0	0	0	0	0	0	0	1	0	0	0	0	1	0	0
A12	0	0	0	0	1	0	0	0	0	1	0	0	0	0	0	0	1	0	0	0	1	0	0	0
A13	0	0	0	0	1	0	0	0	0	1	0	0	0	0	0	0	1	0	0	0	1	0	0	0
D89	0	0	0	0	1	0	0	0	1	1	0	0	0	0	0	0	0	1	0	0	0	0	0	0
D18	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
D50	1	0	0	0	0	0	0	0	0	0	0	0	0	0	1	0	0	0	0	0	0	0	0	0
D66	0	0	0	0	0	0	0	0	0	0	0	1	0	0	0	0	0	0	1	0	0	0	1	0
D73	0	0	0	0	0	0	1	0	0	0	0	0	1	0	0	0	0	0	1	0	0	0	1	0
D74	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	1	0	0	0	1	0
D75	0	0	0	0	0	0	0	1	0	0	0	0	0	1	0	0	0	0	1	0	0	0	0	1
D76	0	1	0	0	0	0	0	1	0	0	0	0	0	1	0	0	0	1	0	0	0	0	1	0
D77	0	0	0	0	0	0	0	0	0	0	0	0	1	0	0	0	0	0	0	1	0	0	0	0
D78	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	1	0	0	0	0	0
D79	0	0	0	0	0	0	0	0	0	0	0	0	1	0	0	0	0	0	0	1	0	1	0	0
D80	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	1	0	0	0	0	0
D81	0	0	0	0	0	0	0	0	0	0	0	0	1	0	0	1	0	0	1	0	0	0	1	0
D88	0	0	0	0	0	1	0	0	0	0	0	0	1	0	0	0	0	0	1	0	0	0	1	0
D90	0	0	1	0	0	0	0	1	0	0	0	0	0	1	0	0	0	0	1	0	0	0	1	0
D91	0	0	1	0	0	0	0	1	0	0	0	0	0	1	0	0	0	0	1	0	0	0	1	0
D94	0	0	0	0	0	0	0	0	0	0	0	0	1	0	0	0	0	0	1	0	0	0	1	0
D96	0	0	0	0	0	0	0	0	0	0	0	0	1	0	0	0	0	0	1	0	0	0	1	0
D97	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
D98	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
D99	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
D117	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
D120	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
D124	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
D126	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
D131	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
D132	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
D137	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
D200	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
D201	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
D232	0	0	0	0	0	0	0	0	0	0	0	1	0	0	0	0	0	0	0	0	0	0	0	0
D234	0	0	0	1	0	0	0	0	0	1	0	0	0	0	0	0	0	0	0	0	0	0	0	0
D236	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
D239	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
D25	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
D253	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
D254	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
D255	0	0	0	0	0	0	0	0	0	0	0	1	0	0	0	0	0	1	0	0	0	0	0	0
D263	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
D277	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0

0= no band; 1= Presence of band

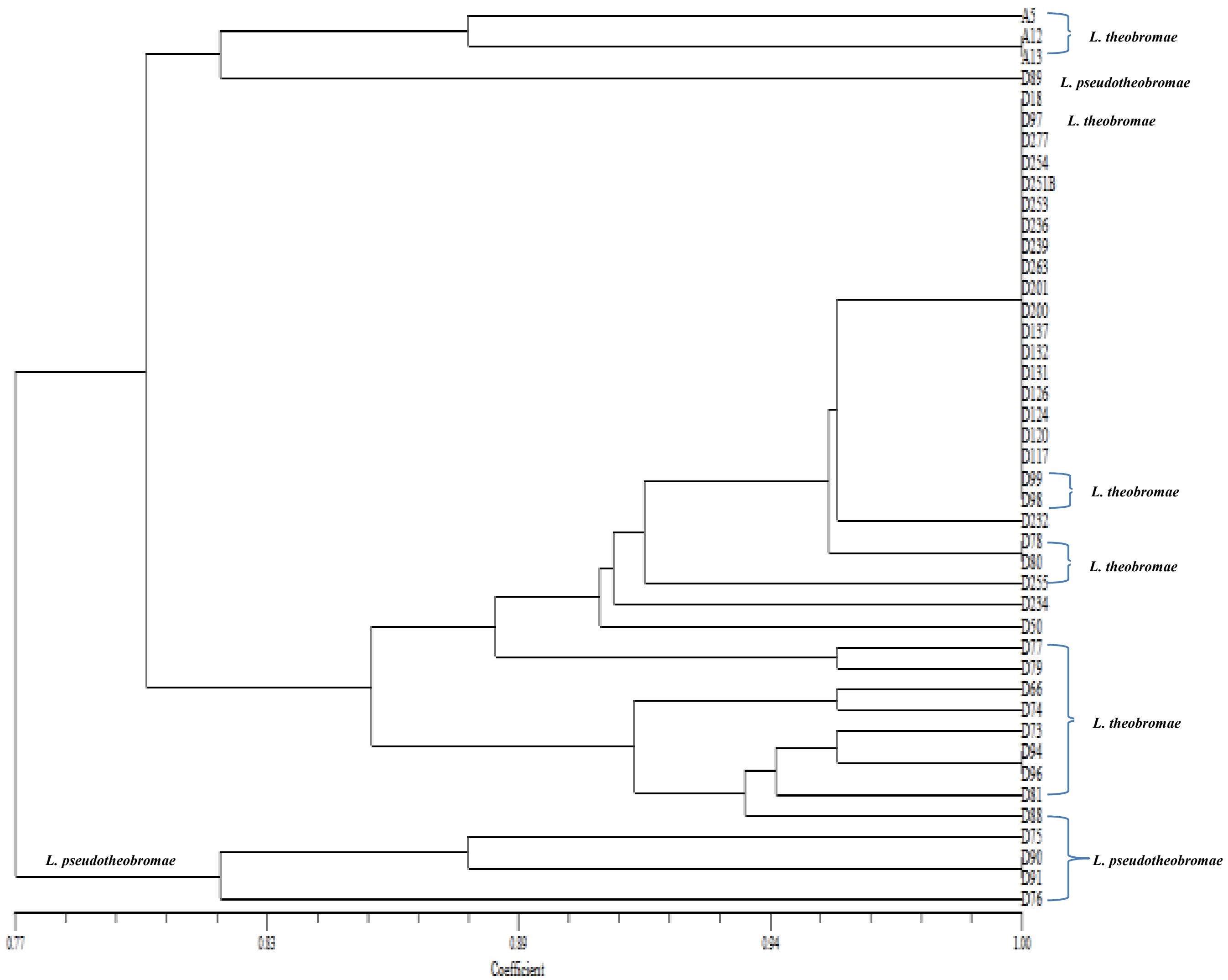


Figure 7-5. Evaluation of the similarity between electrophoretic profiles using the dendrogram based on primer M13 aplification.

PCR product based on primer $(GTG)_5$ electrophoresis result is not clearly definable in some cases due to the intensity (figure 7-6). For this reason we consider only the bands between 377 and 2738 bp that present 28 polymorphic bands (table 7-10). The dendrogram shown in figure 7-7 shows clear separation of all *L. pseudotheobromae* strains in one block with high similarity. On the contrary, *L. theobromae* appears in three separated blocks at different level.

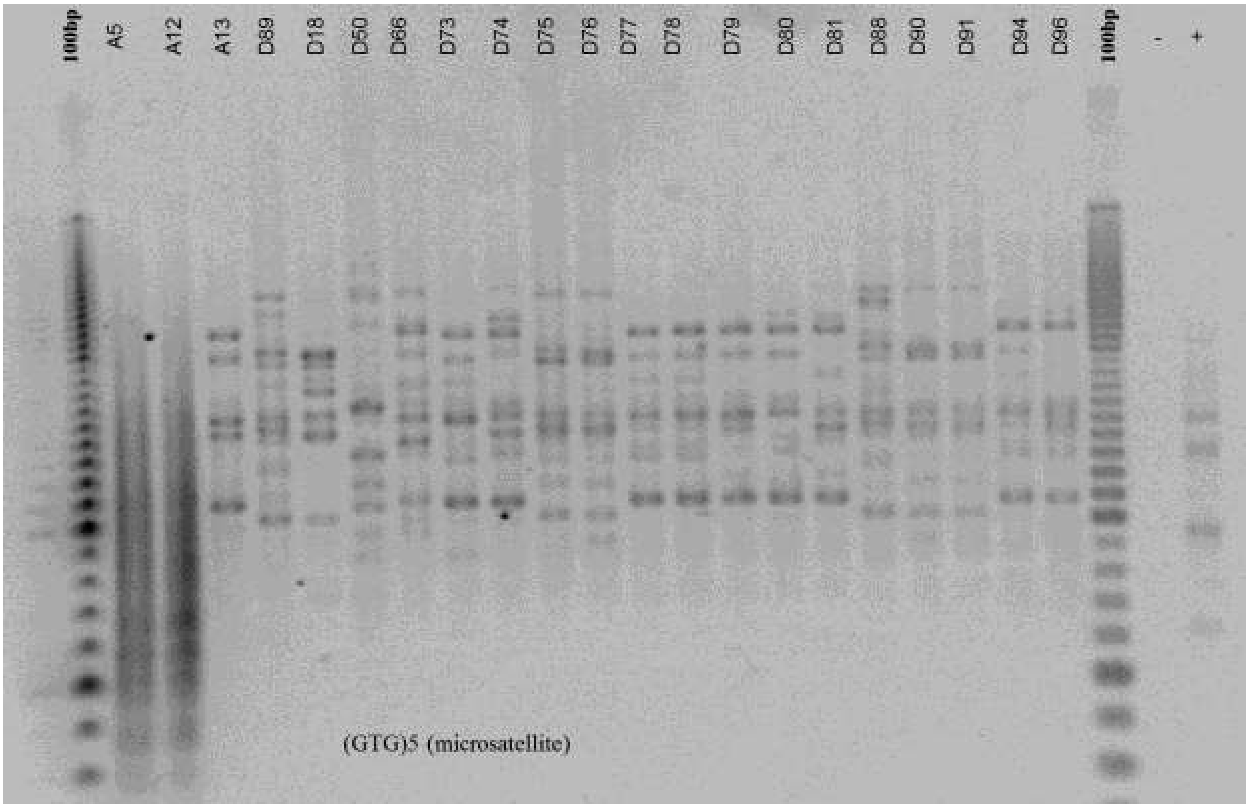


Figure 7-6. Electrophoretic gel image of amplification products obtained with $(GTG)_5$ primer.

Table 7-10. Matrix relative to the electrophoretic profile obtained by $(GTG)_5$ primer.

	Band size (bp)																											
Code	377-387	514-521	573-585	868-899	909-964	1001	1020-1038	1072-1099	1102-1179	1122-1198	1202-1287	1296-1306	1315-1325	1363-1368	1402-1414	1444-1488	1537-1551	1580	1611-1640	1722-1781	1801-1811	1914-1999	2008-2023	2174-2194	2231-2286	2330-2380	2596-2665	2738
A5	1	1	1	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
A12	1	1	1	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
A13	0	0	0	0	0	0	0	1	0	0	0	0	0	0	0	1	0	0	1	0	0	0	0	0	0	0	0	0
D89	0	0	0	0	0	0	1	0	1		1	0	0	0	0	1	1	0	0	1	0	1	1	0	0	1	1	0
D18	0	0	0	0	0	0	1	0	0	1	0	0	1	0	0	1	0	1	0	1	1	1	0	0	0	0	0	0
D50	0	0	0	1	1	0	0	1	0	0	0	0	0	0	0	0	0	0	1	0	0	0	0	0	1	0	1	0
D66	0	0	0	0	0	0	0	1	0	0	0	0	0	0	1	0	1	0	1	1	0	0	1	0	1	0	1	0
D73	0	0	0	1	0	0	1	1	0	0	0	1	0	0	0	0	1	0	0	1	0	1	0	1	0	0	0	0
D74	0	0	0	0	0	0	1	1	0	0	0	0	1	0	0	1	0	1	0	0	0	1	0	1	1	0	0	1
D75	0	0	0	0	0	0	1	0	1	0	0	1	0	0	0	1	1	0	0	0	0	1	1	0	0	0	1	0
D76	0	0	0	0	1	0	1	0	1	0	0	1	0	0	0	1	1	0	0	0	0	1	0	0	0	0	1	0
D77	0	0	0	0	0	0	0	1	0	0	0	0	0	0	0	1	0	0	1	0	0	0	0	0	0	0	0	0
D78	0	0	0	0	0	0	0	1	0	0	0	0	0	0	0	1	0	0	1	0	0	0	0	0	0	0	0	0
D79	0	0	0	0	0	0	0	1	0	0	0	0	0	0	0	1	0	0	1	0	0	0	0	0	0	0	0	0
D80	0	0	0	0	0	0	0	1	0	0	0	0	1	0	1		1	0	1	0	0	1	0	1	1	0	0	0
D81	0	0	0	0	0	0	0	1	0	0	1	0	0	0	0	1	1	0	0	0	1	0	0	1	0	1	0	0
D88	0	0	0	0	0	0	1	0	1	0	1	0	0	0	0	1	1	0	0	1	0	1	1	0	0	1	1	0
D90	0	0	0	0	0	0	1	0	1	0	0	1	0	0	0	1	1	0	0	0	0	1	1	0	0	0	1	0
D91	0	0	0	0	0	0	1	0	1	0	0	1	0	0	0	1	1	0	0	0	0	1	1	0	0	0	1	0
D94	0	0	0	0	0	0	0	1	0	0	0	1	0	0	0	1	1	0	0	0	0	1	0	1	0	0	0	0
D96	0	0	0	0	0	0	0	1	0	0	0	1	0	0	0	1	1	0	0	0	0	1	0	1	0	1	0	0
D97	0	0	0	0	0	1	0	0	0	1	0	0	0	1	0	0	0	0	0	0	0	0	0	0	0	0	0	0

D98	0	0	0	0	1	0	1	0	0	1	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
D99	0	0	0	1	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
D117	0	1	0	0	0	0	0	0	0	1	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
D120	0	0	0	0	1	0	0	0	1	1	1	0	0	0	0	1	0	0	0	0	0	0	0	0	0	0	0	0
D124	0	0	0	0	0	0	0	0	1	0	0	0	1	0	0	1	0	0	0	0	0	0	0	0	0	0	0	0
D126	0	0	0	0	1	0	0	1	0	0	0	1	0	0	0	1	0	0	0	0	0	0	0	0	0	0	0	0
D131	0	1	0	1	0	0	0	0	0	1	0	0	1	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
D132	0	0	0	0	1	0	0	0	0	1	0	0	0	1	0	0	0	0	0	0	0	0	0	0	0	0	0	0
D137	0	0	0	0	1	0	0	0	1	0	1	0	0	0	0	0	0	0	1	0	0	0	0	0	0	0	0	0
D200	0	0	0	0	1	0	0	0	0	1	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
D201	0	0	0	0	1	0	0	0	0	0	0	0	1	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
D232	0	0	0	0	1	0	1	0	0	0	1	0	0	0	1	0	0	0	0	0	0	0	0	0	0	0	0	0
D234	0	0	0	0	1	0	1	0	0	1	0	0	0	0	1	0	0	0	0	0	0	0	0	0	0	0	0	0
D236	0	0	0	0	0	0	1	0	0	0	1	0	0	0	0	1	0	0	0	0	0	0	0	0	0	0	0	0
D239	0	0	0	0	0	0	0	0	0	0	1	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
D25	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
D253	0	0	0	0	0	0	1	0	0	1	0	0	1	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
D254	0	0	0	0	1	0	1	0	0	1	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
D255	0	0	0	1	0	0	0	0	0	0	0	0	0	0	0	1	0	0	0	0	0	0	0	0	0	0	0	0
D263	0	0	1	0	1	0	1	0	0	0	1	0	0	0	0	1	0	0	0	0	0	0	0	0	0	0	0	0
D277	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0

0= no band; 1= Presence of band

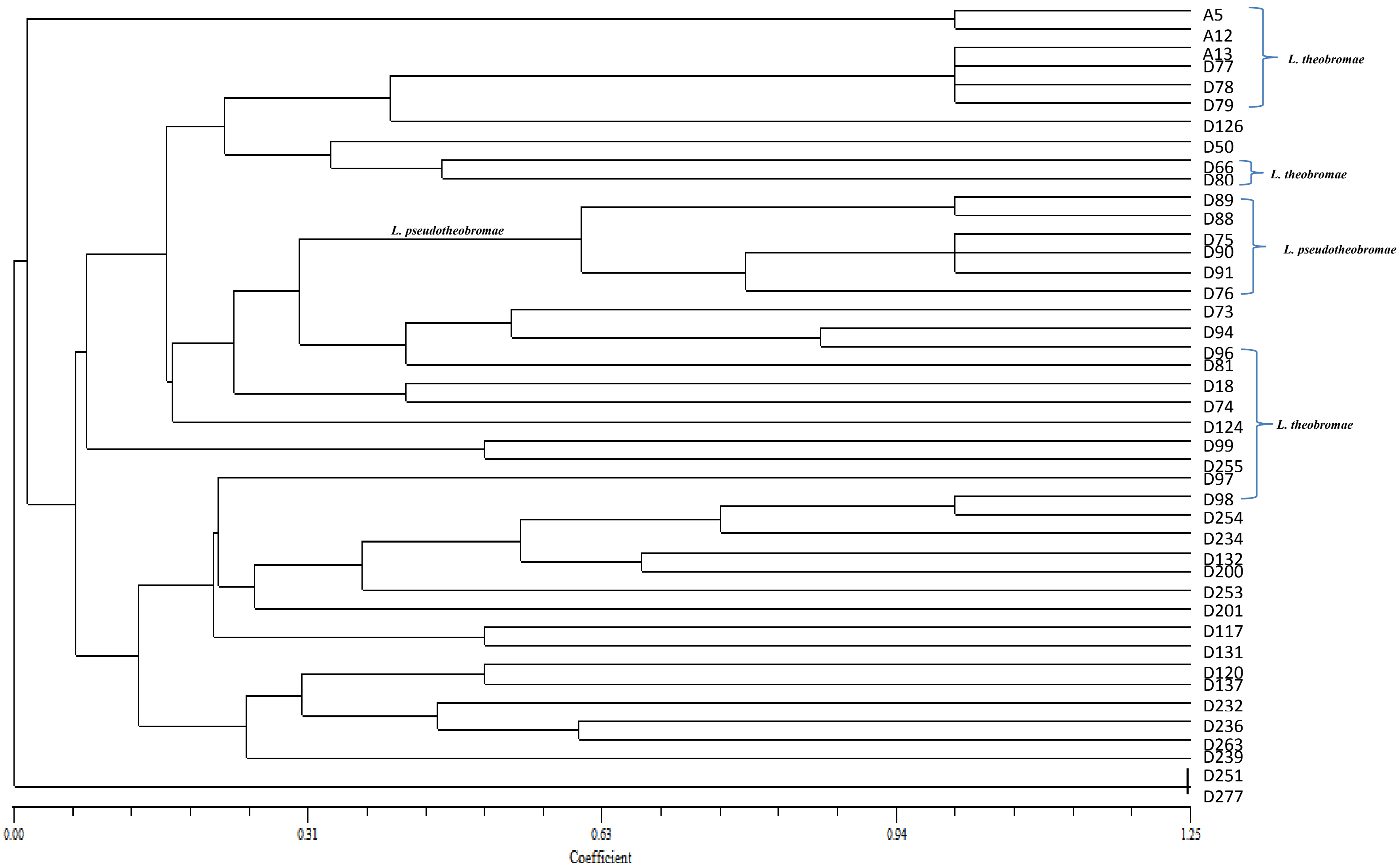


Figure 7-7. Evaluation of the similarity between electrophoretic profiles using the dendrogram based on primer $(GTG)_5$ aplification.

PCR product based on microsatellite primer $(GACA)_4$ showed many bands with various intense but well defined (figure 7-8). It was possible to objectively derive the data relating to the similarity with a small difference of the 18 bands of different size (table 7-11). 36 different profiles presented in the dendrogram that showed two clusters of *L. pseudotheobromae* presented. Unexpectedly, one big cluster of *L. theobromae* strains presented and grouped with high similarity, it was separated from all others strains, except three strains; D97, D98 and D74 (figure 7-9).

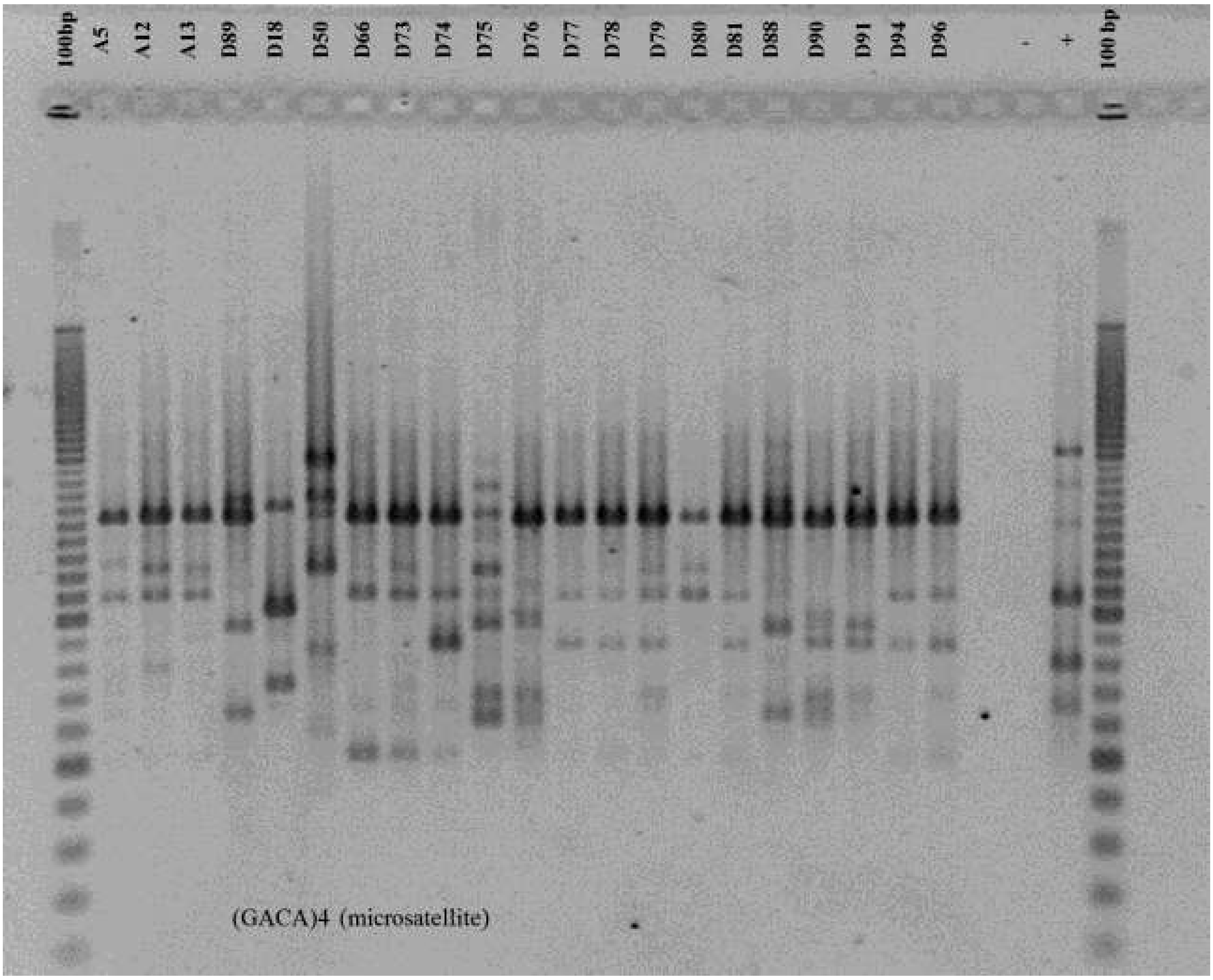


Figure 7-8. Electrophoretic gel image of amplification products obtained with $(GACA)_4$ primer.

Table 7-11. Matrix relative to the electrophoretic profile obtained by $(GACA)_4$ primer.

	Band size (bp)																	
Code	489-515	528-588	601-652	670-707	739-764	798-849	854-895	904-967	973-1038	1057-1098	1100-1162	1219-1245	1251-1285	1436-1473	1530-1589	1640	1706	2003
A5	0	0	0	0	0	0	0	0	0	1	0	0	1	0	1	0	0	0
A12	0	0	0	0	0	1	0	0	0	0	1	1	0	0	1	0	0	0
A13	0	0	0	0	0	0	0	0	0	0	1	1	0	0	1	0	0	0
D89	0	0	1	0	0	0	0	0	1	0	0	0	1	0	1	0	0	0
D18	0	0	0	0	1	0	0	0	0	1	0	0	0	0	0	1	0	0
D50	0	0	1	0	0	0	1	0	0	0	0	0	1	0	1	0	1	1
D66	0	1	0	0	0	0	0	0	0	0	1	0	0	0	1	0	0	0
D73	0	1	0	0	0	0	0	0	0	0	1	0	1	0	1	0	0	0
D74	0	0	0	0	0	0	0	1	0	0	1	0	0	0	1	0	0	0
D75	0	0	1	1	0	0	0	0	1	0	1	1	0	0	1	0	0	0
D76	0	0	1	1	0	0	0	0	1	0	0	0	0	0	1	0	0	0
D77	0	0	0	0	0	0	1	0	0	0	1	0	0	0	1	0	0	0
D78	0	0	0	0	0	0	1	0	0	0	1	0	0	0	1	0	0	0
D79	0	0	0	1	0	0	1	0	0	0	1	1	0	0	1	0	0	0
D80	0	0	0	0	0	0	0	0	0	1	0	1	0	0	1	0	0	0
D81	0	0	0	0	0	0	1	0	0	1	0	0	0	0	1	0	0	0
D88	0	0	1	0	0	0	0	1	0	0	0	0	0	0	1	0	0	0
D90	0	0	0	1	0	0	1	1	0	0	0	0	0	0	1	0	0	0
D91	0	0	0	0	0	0	1	1	0	0	0	0	0	0	1	0	0	0
D94	0	0	0	0	0	0	1	0	0	1	0	0	0	0	1	0	0	0
D96	0	0	0	0	0	0	1	0	0	1	0	0	0	0	1	0	0	0
D97	0	1	0	0	0	1	0	0	1	0	0	0	0	0	1	0	0	0
D98	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
D99	0	0	0	0	0	0	0	0	0	0	0	0	0	0	1	0	0	0
D117	0	1	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
D120	0	0	0	0	1	0	1	0	0	0	0	0	0	0	0	0	0	0
D124	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
D126	0	0	0	0	0	0	0	0	0	1	0	0	0	0	0	0	0	0
D131	0	0	0	0	0	1	0	0	0	0	0	0	0	0	0	0	0	0
D132	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
D137	0	0	0	0	0	0	0	1	0	0	0	0	0	0	0	0	0	0
D200	1	1	0	0	0	0	1	0	0	0	1	0	0	0	0	0	0	0
D201	1	1	0	0	0	0	1	0	1	0	0	0	0	1	0	0	0	0
D232	0	0	0	0	0	0	1	1	0	0	0	0	1	0	0	0	0	0
D234	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
D236	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
D239	0	0	0	0	0	0	0	1	0	0	0	0	0	0	0	0	0	0
D25	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
D253	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
D254	0	0	0	1	0	0	0	0	0	0	1	0	0	0	0	0	0	0
D255	1	0	0	0	0	0	0	0	0	0	1	0	0	0	1	0	0	0
D263	0	0	0	0	1	0	0	0	0	0	0	0	0	1	0	0	0	0
D277	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0

0= no band; 1= Presence of band

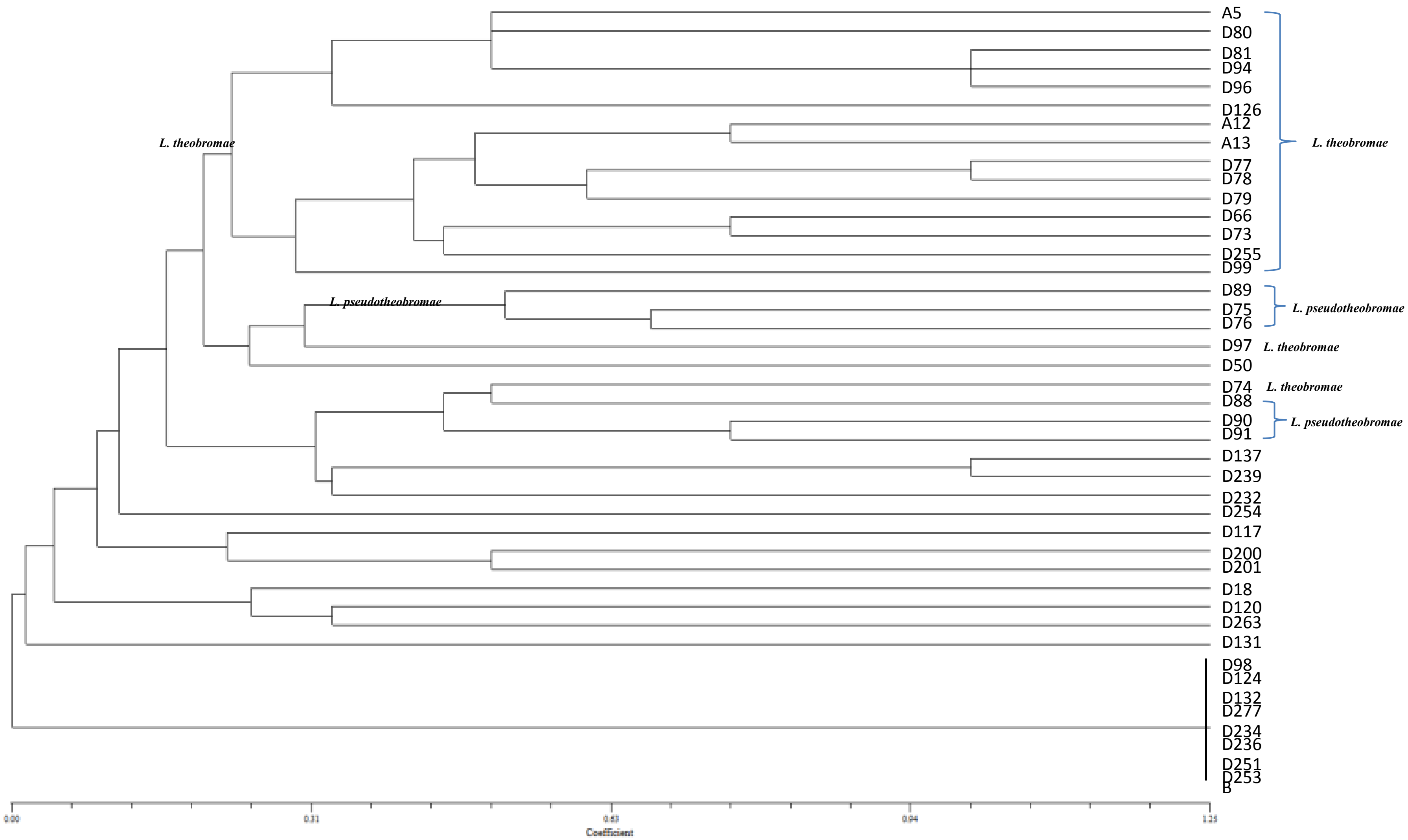


Figure 7-9. Evaluation of the similarity between electrophoretic profiles using the dendrogram based on primer (GACA)$_4$ aplification.

8 Chapter Eight : Conclusion.

8.1 **Conclusion**

The composition of the etiological agents isolated from various organic banana samples from Dominican Republic was similar to those found in other banana cultivation areas affected by crown rot disease (Goos and Tschirsch, 1962; Johanson and Blazquez, 1992; Anthony *et al.*, 2004; Alvindia and Natsuaki, 2008; Lassois *et al.*, 2008; Lassois *et al.*, 2010b; Ewane *et al.*, 2013). However, the Dominican population was characterized by some peculiar taxa, e.g. *F. sacchari, F. musae, F. dimerum, F. proliferatum, F. pseudocircinatum, Alternaria* spp., *Curvularia* spp., and *Microdochium* sp., which were not previously reported. To the best of our knowledge, this is the first time when these species were isolated from asymptomatic crown tissues. These results concerning strain identification, e.g. identification of *F. musae*, was possible thanks to the progress in identification approaches and the presence of new taxonomic group. This underlines the need to update the various references, identification keys and databases in accordance with the new identification approaches.

Considering the important results in our hands, the genus *Fusarium* was the most frequent genus among all isolated fungi, further confirming its importance in the etiology of crown rot disease. Moreover, the species belonging to *Fusarium* genus can be ranked as follows based on their frequency and pathogenicity; *F. incarnatum*, *C. musae*, *F. sacchari, F. verticillioides, L. theobromae* and *L. pseudotheobromae*. These etiological agents were isolated from samples collected from all banana handling processes, as well as in field from banana flowers even before fruit formation. They were present in high rates, which indicate that they play a role as the source of primary infection. As far as we can tell, they are transmitted from field to packaging stations either on the outer surfaces of fruits or inside crown tissues as demonstrated by our results. The secondary infection and the diffusion of this disease occurs - becomes critical - when bananas are processed through the dehanding and washing tanks, the final crown trimming and the application of protective products on freshly trimmed crowns. The removal of large parts of crown tissues takes place after the dehanding and first washing phases, consequently the inoculum can access freshly wounded and trimmed crown tissues. The core of the problem, therefore, is passing from the second washing tanks to the application of protective products, which represents the critical point for the disease spread. Our results further indicate that the strains of *Colletotrichum* were mainly located inside crown tissues. On the contrary, strains of *Lasiodiplodia* were located in the outer surface, while the *Fusarium* strains were isolated from both tissues. Some strains are associated with crown tissues, but we cannot give them the same level of importance, as they were isolated less frequently and were not pathogenic, moreover, some of them were considered saprophytes or pathogens of postharvest diseases on other hosts. Despite this, they cannot be excluded completely, as they can have a minor role in the crown rot development as a complex disease, by facilitating the infection.

Considering fungal strains belonging to the most important crown rot pathogens, our results showed a high variability among strains based on morphological and molecular aspects. It was hard to group different representative strains by similarity considering all the criteria observed, especially due to lack of updated identification keys based on phenotypical aspects, as many studies nowadays follow only the molecular characterization. This is a challenge in itself, given the amount of non-real or unreliable results, which appear on different databases; therefore we need more precision and focus on the validity of different outcomes before adopting a method. We have stated the characterization of strains belonging to *Fusarium* using molecular methods described recently. However, it was really hard to get information on exact composition of the PCR mixture and reaction conditions using TEF primer. Considering what has been published and cited many times as a reference of these methods (O'Donnell and Cigelnik, 1997; O'Donnell *et al.*, 1998; O'Donnell *et al.*, 1998; O'Donnell *et al.*, 2009), the information was always incomplete, even when we reproduced the same methods as cited, we did not get the expected results. Consequently it was very difficult to optimize the method.

Concerning the management of crown rot disease, the use of synthetic fungicides is quick and easy solution in many cases, but it was restricted and regulated in organic farming. Since we could not use fungicides in this case, the main problem in organic banana cultivation was attributed to non-compliance of sanitary measures during handling process. Based on results of this work we summarize and propose the following management strategy: firstly, In case of such a complex disease, it is necessary to comply with proposed sanitary measures during field and handling processes, starting with healthy non-infected plant material as well as maintaining the quality of water used in the washing tanks and ensuring that there is the recommended ratio of chlorine at all times. Based on our results, passing through the second washing tanks and the application of protective products were the critical points for the disease spread. Consequently, it is particularly evident that cleanliness and sterilization of tools used for pruning flowers and knives used to trim the crown parts, as well as pumps used for various treatments, were critical as well.

Finally, this work is considered the first study covering Dominican Republic and focuses on organic cultivation of bananas. We believe that it is of utmost importance to find scientific and practical solutions to such an important problem as crown rot. This disease causes significant loss in food production and the expansion of the food gap, especially in developing countries, where they depend on the cultivation and export of such important crops as bananas.

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10 Annexes

Annex A-1. Nucleotide sequences of all representatives strains.

Code	Priemr	Sequence
355IN1	ApMat (AMf)	AGTCTGCAGTGGCGAAGAGCAACGTGTGGGCGAATCAATGGT CCTCATGGCGGGGGGTAAAAGACACTCTAGGTATCGGGCTGG AATAGATGTTCCATGAAGAGGATATTTACTGGCTTGCAGATTG TAATTACAGAAAAAGATTCGTGTTCGCTTGACATGCGAATACA TGGGTTGTGAGTACATTTTTCCACCAATATGGTCATCAAATCG AAGATCTCTGCTTCGCGTTGCCATCGAAGCAGATGGTCCAGGA TGATTCTTGGTTCCTCAGATCCGGTGATCTCCTAGCGTTCGCAC GTCGAAGTATCGCCGCACAAAGGTCTGTTGGTTTCTCGCGCAG GTAACTCTTGCCACAGCATGCGGGAAGTGAATCGACGACCA
361IN1	ApMat (AMf)	CAGACCTAGTTATTCACGTGATGCGCAGTCGAGACAGTGGCTG GGCATCATGGATGTGTTGGCAGTCTGCAGTGGCGAAGAGCAA CGTGTGGGCGAATCAATGGTCCTCATGGCGGGGGGTAAAAGA CACTCTAGGTATCGGGCTGGAATAGATGTTCCATGAAGAGGAT ATTTACTGGCTTGCAGATTGTAATTACAGAAAAAGATTCGTGT TCGCTTGACATGCGAATACATGGGTTGTGAGTACATTTTTCCA CCAATATGGTCATCAAATCGAAGATCTCTGCTTCGCGTTGCCA TCGAAGCAGATGGTCCAGGATGATTCTTGGTTCCTCAGATCCG GTGATCTCCTAGCGTTCGCACGTCGAAGTATCGCCGCACAAAG GTCTGTTGGTTTCTCGCGCAGGTAACTCTTGCCACAGCATGCG GGAAGTGAATCGACGACCAGGTGCGCGGTCGCCTCCTGGGTC ACGCTGACTGGATAGAGATCGAAGACAGCCTCCAAAGGCGCC ATGTTCTGAGGCTCCTCTGGTCGCTGATGCTGCCAGTCTAGAA CACAAGGACGACCTAGAGTCGTCTGGCAGCGCCGATATCTATT CAGTTCCATGACTGATACTACAGCGAATTTTCGCAGTCGGTAG GTATAACTCATACTCCTCCCGTCTGGAGCCGACAAGTCGGCGC GCTGATGGGTT
974IN1	ApMat (AMf)	AGTTATTCCGTGATGCGCAGTCGAGACAGTGGCTGGGCATCAT GGATGTGTTGGCAGTCTGCAGTGGCGAAGAGCAACGTGTGGG CGAATCAATGGTCCTCATGGCGGGGGGTAAAAGACACTCTAG GTATCGGGCTGGAATAGATGTTCCATGAAGAGGATATTTACTG GCTTGCAGATTGTAATTACAGAAAAAGATTCGTGTTCGCTTGA

		CATGCGAATACATGGGTTGTGAGTACATTTTTCCACCAATATG GTCATCAAATCGAAGATCTCTGCTTCGCGTTGCCATCGAAGCA GATGGTCCAGGATGATTCTTGGTTCCTCAGATCCGGTGATCTC CTAGCGTTCGCACGTCGAAGTATCGCCGCACAAAGGTCTGTTG GTTTCTCGCGCA
A04	ITS (ITS1)	GGGGGCTCCGAGCTTAACTCCAACCCCTGTGACATACCAATTG TTGCCTCGGCGGATCAGCCCGCTCCCGGTAAAACGGGACGGCC CGCCAGAGGACCCCTAAACTCTGTTTCTATATGTAACTTCTGA GTAAAACCATAAATAAATCAAAACTTTCAACAACGGATCTCTT GGTTCTGGCATCGATGAAGAACGCAGCAAAATGCGATAAGTA ATGTGAATTGCAGAATTCAGTGAATCATCGAATCTTTGAACGC ACATTGCGCCCGCCAGTATTCTGGCGGGCATGCCTGTTCGAGC GTCATTTCAACCCTCAAGCCCAGCTTGGTGTTGGGACTCGCGA GTCAAATCGCGTTCCCCAAATTGATTGGCGGTCACGTCGAGCT TCCATAGCGTAGTAGTAAAACCCTCGTTACTGGTAATCGTCGC GGCCACGCCGTTAAACCCCAACTTCTGAATGTTGACCTCGGAT CAGGTAGGAATACCCGCTGAACTTAAGCATATCAATAAGCGG AGGAAATTCCAACCCCTGGCAGAGAAACAATTGTTTGTTTGGC CAAAAAACAAACCCCGCCACAAAGAGGGGCGGCCCCGGCACA CCACCCAAATTCTTTTTTTTTTTTTTTTTTTGTATCAAAAAAAA ATAA
A05	ITS (ITS1)	GGGCACGGGCTTCGAGCTCGGCTCGACTCTCCCACCCTTTGTG ACGTACCTCTGTTGCTTTGGCGGCTCCGGCCGCCAAAGGACCT TCAAACTCCAGTCAGTAAACGCAGACGTCTGATAAACAAGTTA ATAAACTAAAACTTTCAACAACGGATCTCTTGGTTCTGGCATC GATGAAGAACGCAGCGAAATGCGATAAGTAATGTGAATTGCA GAATTCAGTGAATCATCGAATCTTTGAACGCACATTGCGCCCC TTGGTATTCCGGGGGGCATGCCTGTTCGAGCGTCATTACAACC CTCAAGCTCTGCTTGGAATTGGGCACCGTCCTCACTGCGGACG CGCCTCAAAGACCTCGGCGGTGGCTGTTCAGCCCTCAAGCGTA GTAGAATACACCTCGCTTTGGAGCGGTTGGCGTCGCCCGCCGG ACGAACCTTCTGAACTTTTCTCAAGGTTGACCTCGGATCAGGT AGGGATACCCGCTGAACTTAAGCATATCAATAAGGCGGAGGG

		ATCCGGCCCCACCCTCCCCCCTTGGGGAACGTACTCTGTTGCTT TGGGCGGCTCCGGCGCCCAAGGAACTTTAAACTCCGTTCGTAA ACGCAA
A07	ITS (ITS1)	GGGCCAGAGTTTACTCTCCAACCATGTGAACTTACCACTGTTG CCTCGGTGGTTTGGTCTTCGGACTGACCACCGGCGGACCACTA AACTCTTGTTAATTTATGGCATTCTGAATCATAACTAAGAAAT AAGTTAAAACTTTCAACAACGGATCTCTTGGTTCTGGCATCGA TGAAGAACGCAGCGAAATGCGATAAGTAATGTGAATTGCAGA ATTCAGTGAATCATCGAATCTTTGAACGCACATTGCGCCCATT AGTATTCTAGTGGGCATGCCTGTTCGAGCGTCATTTCAACCCTT AAGCCTAGCTTAGTGTTGGGAGACTGCCTAATACGCAGCTCCT CAAAACCAGTGGCGGAGTCTGTTCGTGCTCTGAGCGTAGTAAT TCTTTATCTCGCTTCTGTCAGCCGGCCAGACGACAGCCATAAA CCGCACCCTTCGGGGGCACTTTTTAATGGTTGACCTCGGATC AGGTAGGAATACCCGCTGAACTTAAGCAGATCAATAGGCGAG AGGAGAAATCTCCAAACCATGGGAACTTACACTGTTGCCCGGT TGGGTTGGTCTTCGGGACTGACCCGGGGGAAACTAAACTCTTG TTAATTTATGGGCATTCTGGAATCATAACTAAAGAAAATAAAG TTAAAACTTTCAACAACGGGATCTCTTGGGTTCTGGGCATCTA TGGAAGACGCAGGCAAATGGGATAAGTGATGTGAATGCAGGA TTCAGTGATCATCGGATCTTTGAACGCCATGCGGCATAGTATC TGTGGGCATGCTGGTCGAGCGTCATTTACCTAACTAACAAGTT GGGGAAGTGGCTATACAGCTGCAGCAGGACGACGCTGGCTAG AAGAATATATTATATGTCTGCACAGAGAACGACCTGCGCGGTT ATGTAGTGACGGGGATACTACTACTACTGGGGAGAAC
A07	ß- TUBUL IN (BT2)	GGGGTTCCAATCTCCTTTACTTCGACACACCACTGCCTCTGCA ACGAAGACGAAGACGACCGCATATCCACGAATTTTCGGAAGG CTTCGGTCGCAAGTGCTTGGGAGGCCAGATTGAGACTGGTGAG GCTAACGTTCTTACCCGAATACAGGCAGACCATCTCCAGCGAG CACGGTCTCGACAGCAATGGCGTGTAAGTACAACGATCTGCTC GCGGTCCTTCTTCCCTTCTGGAGGGCGGTAGATTCTATGTCACC TGAAAGAAATCAATGCTGACACTGCGTCAATAGCTACAACGG CACCTCCGAGCTCCAGCTCGAGCGCATGAGCGTCTACTTCAAC

		GAGGTAATTCACTTCGAAGCCAAATCATGACCGAGCAGACGC CTAATCACAATGTCTTCTAGGCCTCTGGCAACAAGTACGTCCC TCGCGCCGTTCTCGTCGATCTCGAGCCCGGTACCATGGACGCC GTCCGTGCTGGCCCCTTCGGTCAGCTCTTCCGCCCCGACAACTT CGTCTTCGGTCAGTCTGGTGCTGGCAACAACTGGGCCAAGGAT CACTACACTGAGGGTA
A09	ITS (ITS1)	GGGGCCTCGGACTCACTCCAAACCCCTGTGACATACCAATTGT TGCCTCGGCGGATCAGCCCGCTCCCGGTAAAACGGGACGGCC CGCCAGAGGACCCCTAAACTCTGTTTCTATATGTAACTTCTGA GTAAAACCATAAATAAATCAAAACTTTCAACAACGGATCTCTT GGTTCTGGCATCGATGAAGAACGCAGCAAAATGCGATAAGTA ATGTGAATTGCAGAATTCAGTGAATCATCGAATCTTTGAACGC ACATTGCGCCCGCCAGTATTCTGGCGGGCATGCCTGTTCGAGC GTCATTTCAACCCTCAAGCCCAGCTTGGTGTTGGGACTCGCGA GTCAAATCGCGTTCCCCAAATTGATTGGCGGTCACGTCGAGCT TCCATAGCGTAGTAGTAAAACCCTCGTTACTGGTAATCGTCGC GGCCACGCCGTTAAACCCCAACTTCTGAATGTTGACCTCGGAT CAGGTAGGAATACCCGCTGAACTTAAGCATATCAATAAGGCG GAGGAAACTCCAAACCCTGTGAACATACCAATTGTTGCCTTGG GGGA
A12	ITS (ITS1)	GGGGTCGGAGCTTCGAGCTCGGCTCGACTCTCCCACCCTTTGT GAACGTACCTCTGTTGCTTTGGCGGCTCCGGCCGCCAAAGGAC CTTCAAACTCCAGTCAGTAAACGCAGACGTCTGATAAACAAGT TAATAAACTAAAACTTTCAACAACGGATCTCTTGGTTCTGGCA TCGATGAAGAACGCAGCGAAATGCGATAAGTAATGTGAATTG CAGAATTCAGTGAATCATCGAATCTTTGAACGCACATTGCGCC CCTTGGTATTCCGGGGGGCATGCCTGTTCGAGCGTCATTACAA CCCTCAAGCTCTGCTTGGAATTGGGCACCGTCCTCACTGCGGA CGCGCCTCAAAGACCTCGGCGGTGGCTGTTCAGCCCTCAAGCG TAGTAGAATACACCTCGCTTTGGAGCGGTTGGCGTCGCCCGCC GGACGAACCTTCTGAACTTTTCTCAAGGTTGACCTCGGATCAG GTAGGGATACCCGCTGAACTTAAAAATATCAAAACGCGGATG AGAGTTGGGTCATTTTCAACTTTGGGAAACTTACCCTGTTGCTT

		TTTGGGGGTCCGGCCCCAAGGGCCTTTAAACCCCTTCATAAAG CAGAAGTTTGA
A12	ß- TUBUL IN (BT2)	GGGTGGGTGGGAAACCTCCTGCTCCTGCGCCCCCGCTGACGG AAGCGACACCATAGGCAGACCATCTCCGGCGAGCACGGCCTG GATGGCTCCGGTGTGTAAGTGTGCGCCTTCTCCGCCGCGCATG GCAATCGCTGACCTGTAGCAGCTACAATGGCACTTCGGACCTC CAACTGGAGCGCATGAACGTCTACTTCAACGAGGTACTCTCTC CATAATTAGACAAACACGTAAAGTATGGCAATCTTCTGAACGC GCAGCAGGCGTCCAACAACAAGTACGTTCCTCGTGCTGTCCTC GTCGACCTCGAGCCCGGCACCATGGATGCCGTCCGCGCCGGCC CCTTCGGCCAGCTCTTCCGCCCCGACAACTTCGTCTTCGGCCA GTCTGGTGCCGGTAACAACTGGGCCAAGGATCACTAAAATGA GGGTA
A13	ITS (ITS1)	GGGGCACGGGCTTTCGAGCTCGGCTCGACTCTCCCACCCTTTG TGAACGTACCTCTGTTGCTTTGGCGGCTCCGGCCGCCAAAGGA CCTTCAAACTCCAGTCAGTAAACGCAGACGTCTGATAAACAAG TTAATAAACTAAAACTTTCAACAACGGATCTCTTGGTTCTGGC ATCGATGAAGAACGCAGCGAAATGCGATAAGTAATGTGAATT GCAGAATTCAGTGAATCATCGAATCTTTGAACGCACATTGCGC CCCTTGGTATTCCGGGGGGCATGCCTGTTCGAGCGTCATTACA ACCCTCAAGCTCTGCTTGGAATTGGGCACCGTCCTCACTGCGG ACGCGCCTCAAAGACCTCGGCGGTGGCTGTTCAGCCCTCAAGC GTAGTAGAATACACCTCGCTTTGGAGCGGTTGGCGTCGCCCGC CGGACGAACCTTCTGAACTTTTCTCAAGGTTGACCTCGGATCA GGTAGGGATACCCGCTGAACTTAAGCATATCAATAAGACGGA GGAATTCCGCTCCACCTCCCCCCCTTGTGAAAGTAACTCTGTT GCTTTGGGGGGTTCCGGCGCCCAAGGACCTTCAACTCAGTCAG TAAAAGCAAAGTCTGAATAAACAAGTTAATAAAACTAAAAAT TTTAACACGAACTCTTGGGTTCTGGCATCGATGAAGAAACGAA CAAAAGGCCATGAGTAATGTGAATTGCGAGAATTCAATGAAA TCATCGAATCTTGATCTCAGATGGCTTGGGCTATTCCGGGGGG CATGCGGTCGAGCTCTTCACCATCTACTCGCGAATTGGGCTGC GAGCGCTACGACCTCGGCGTGCGTCAACTAGTCTATACATAAC

		CTGATTGAAGCGTGCGTGCGCGCACTTCGACGTTTCAGTGAGC GGATCAGCCTGAATCAGTATGACGGAGGAGCA
A15	ß- TUBUL IN (BT2)	GGTCTCTCTGGCGAGCCGGTCTCGACAGCAATGGTGTTTACAA CGGTACCTCCGAGCTCCAGCTCGAGCGTATGAGCGTCTACTTC AACGAGGTTTGTTTCATCACTCCTGCCACGAAAACACAACAAG CTCACGCGCGCCTAGGCTTCCGGTAACAAGTATGTTCCCCGTG CCGTCCTCGTCGATCTCGAGCCCGGTACCATGGACGCCGTCCG TGCCGGTCCTTTCGGACAGCTTTTCCGTCCCGACAACTTCGTTT TCGGTCAATCCGGTGCCGGAAACAACTGGGCCAAGGGTCACT ACACTGAGGGTA
A15	ß- TUBUL IN (BT1)	GGGGCCCCATCATGACAGCCGTGGTGCTCACTCTTTCCGCGCT GTCAGCGTTCCTGAGCTGACCCAGCAGATGTTCGACCCCAAGA ACATGATGGCTGCTTCCGACTTCCGCAACGGTCGTTACCTGAC CTGTTCTGCCATCTTCCGTGGCCGCGTCGCCATGAAGGAGGTC GAGGACCAGATGCGCAACGTTCAGAACAAGAACTCATCTTATT TCGTCGAGTGGATCCCTAACAACATCCAGACCGCTCTCTGCGC TATTCCTCCTCGGGGACTTACTATGTCCTCTACCTTTATTGGAA ACTCCACCTCTATCCAGGAGCTTTTCAAGCGTGTTGGCGAGCA GTTTACTGCTATGTTCCGACGCAAGGCTTTCTTGCATTGGTACA CTGGTGAGGGTATGGACGAGATGGAGTTCACTGAGGCTGAGT TCAACAAGAACGATCTCATC
A15	TEF (EF1)	GCCAGATGTGGCGGGGTAATTTCAACTTGAATATTTGCTGACA AGATTGCATAGACCGGTCACTTGATCTACCAGTGCGGTGGTAT CGACAAGCGAACCATCGAGAAGTTCGAGAAGGTTGGTTTCCA TTTCCCCGATCGCACGCCGTCTACCCACCGATCCATCAGTCGA ATCAGTTACGACGATTGAATATGCGCCTGTTACCCCGCTCGAG TACAAAATTTTGCGGTTCAACCGTAATTTTTTGGTGGGGTTTC AACCCCGCTACTCGAGCGACAG
A15	ITS (ITS1)	GGGGGTCGGGGCTCACTCAACCCCTGTGACATACCTATACGTT GCCTCGGCGGATCAGCCCGCGCCCCGTAAAACGGGACGGCCC GCCCGAGGACCCCTAAACTCTGTTTTTAGTGGAACTTCTGAGT AAAACAAACAAATAAATCAAAACTTTCAACAACGGATCTCTT

		GGTTCTGGCATCGATGAAGAACGCAGCAAAATGCGATAAGTA ATGTGAATTGCAGAATTCAGTGAATCATCGAATCTTTGAACGC ACATTGCGCCCGCCAGTATTCTGGCGGGCATGCCTGTTCGAGC GTCATTTCAACCCTCAAGCTCAGCTTGGTGTTGGGACTCGCGG TAACCCGCGTTCCCCAAATCGATTGGCGGTCACGTCGAGCTTC CATAGCGTAGTAATCATACACCTCGTTACTGGTAATCGTCGCG GCCACGCCGTTAAACCCCAACTTCTGAATGTTGACCTCGGATC AGGTAGGAATACCCGCTGAACTTAAGCATATCAATAGGCGGA GGAATAATCCCCAACCCCCGGAAAAAAATA
A16	ß-TUBULIN (BT2)	GTGGACTCTCCTGGCGAGCCGGTCTCGACAGCAATGGTGTTTA CAACGGTACCTCCGAGCTCCAGCTCGAGCGTATGAGCGTCTAC TTCAACGAGGTTTGTTTTATCTCTCCTGCCACGAAAACACAAC AAGCTCACGCGCGCCTAGGCTTCCGGTAACAAGTATGTTCCCC GTGCCGTCCTCGTCGATCTCGAGCCCGGTACCATGGACGCTGT CCGTGCTGGTCCTTTCGGACAGCTTTTCCGTCCCGACAACTTCG TTTTCGGTCAATCCGGTGCCGGAAACAACTGGGCCAAGGGTCA CTAAACTGAGGGTA
A16	ß-TUBULIN (BT1)	GAGCTTCTCCTCATGACAGCCGTGGTGCTCACTCTTTCCGCGCT GTCAGCGTTCCTGAGCTGACCCAGCAGATGTTCGACCCCAAGA ACATGATGGCTGCTTCCGACTTCCGCAACGGTCGTTACCTGAC CTGCTCTGCCATCTTCCGTGGCCGCGTCGCCATGAAGGAGGTC GAGGACCAGATGCGCAACGTTCAGAACAAGAACTCATCTTAC TTCGTCGAGTGGATTCCTAACAACATCCAGACCGCTCTCTGCG CTATTCCTCCTCGGGGACTTACTATGTCCTCTACCTTTATTGGA AACTCCACCTCTATCCAGGAGCTTTTCAAGCGTGTTGGCGAGC AGTTCACTGCTATGTTCCGACGCAAGGCTTTCTTGCATTGGTAC ACTGGTGAGGGTATGGACGAGATGGAGTTCACTGAGGCTGAG TTCAACATGAACGATCTCATCGAGCATGCAGCAATCGTCTCAT TTAGGGGAAGACCAATTGTTGAGGGAACGGATCATCCCGCTCC CGGTAAAACGGGACGGACCGCCAGAGGACCCCTAAACTCTGT TTCTATATGTAACCTCTGAGTAAAACCATAAATAAATCAAAAC TTTCAACAACGGATCTCTTGGTTCTGGCATCGATGAAGAACGC AGCAAAATGCGATAAGTAATGTGAATTGCATAATTCAGTGAAT

		CATCTAATCTTTGAACGCACATTGCGCCCGCCAGTATTCTGGC GGGCATGCCTGTTCGAGCGTCATTTCAACCCTCAAGCCCCCGG GTTTGGTGTTGGGGATTGGCGAGCCCTTTTTGTTTGTCGGTCCT TAAATCTTTGGCTTTTTCTCTGCATTTTC
A16	ITS (ITS1)	GGGGGGAACGGACTAACTCCAACCCCTGTGACATACCTATAC GTTGCCTCGGCGGATCAGCCCGCGCCCTGTAAAACGGGACGG CCCGCCCGAGGACCCTAAACTCTGTTTTTAGTGGAACTTCTGA GTAAAACAAACAAATAAATCAAAACTTTCAACAACGGATCTC TTGGTTCTGGCATCGATGAAGAACGCAGCAAAATGCGATAAG TAATGTGAATTGCAGAATTCAGTGAATCATCGAATCTTTGAAC GCACATTGCGCCCGCCAGTATTCTGGCGGGCATGCCTGTTCGA GCGTCATTTCAACCCTCAAGCTCAGCTTGGTGTTGGGACTCGC GGTAACCCGCGTTCCCCAAATCGATTGGCGGTCACGTCGAGCT TCCATAGCGTAGTAATCATACACCTCGTTACTGGTAATCGTCG CGGCCACGCCGTAAAACCCCAACTTCTGAATGTTGACCTCGGA TCAGGTAGGAATACCCGCTGAACTTAAGCATATCAATAAGGC GGAGGAAGTCCCACCCCCCCCCTAGAAAAAATTTCTTTTATCA GCTGGCATGACCCCCCCCCTGCATAATTATTTTGACCTCCAAAG AACTACACCACAGTTTGTTTTTGAAGTTGTTTTTAAAAAAAAA AAAAAA
B01	ß-TUBULIN (BT1)	GGGGAAGTTGCGATCTAACGAGCGAGCGCGCTCACTCTTTCCG CGCTGTCCCGTTCCTGAGTTGACCCACCAGATGTTCGACCCCA AGAAATGATGGCTGCTTCGGACTTCCGCAATGGTCGCTACCTG ACCTGCTCGGCCATTTTGTGAGTGAACCCGATTTGCGCATGGA AATTATTTACTGACTTTCAACAGCCGTGGCCGTGTCGCTATGA AGGAGGTCGAGGACCAGATGCGCAACGTCCAGAACAAGAACT CTTCTTACTTCGTTGAATGGATTCCCAACAACATCCAGACAGC CCTTTGTGCCATCCCTCCCCGAGGACTTACGATGTCTTCGACCT TCATCGGAAACTCCACTTCTATCCAGGAGCTCTTCAAGCGTGT TGGTGAGCAGTTCACTGCCATGTTCCGACGCAAGGCTTTCTTG CATTGGTATACTGGTGAGGGTATGGACGAGATGGAGTTCACTG AGGCTGACAAAACAACAAGAACGATCTCATCAA

B01	ITS (ITS1)	GGGACGGGGGCCTCCCAACCCCTGTGACATACCAATTGTTGCC TCGGCGGATCAGCCCGCTCCCGGTAAAACGGGACGGCCCGCC AGAGGACCCCTAAACTCTGTTTCTATATGTAACTTCTGAGTAA AACCATAAATAAATCAAAACTTTCAACAACGGATCTCTTGGTT CTGGCATCGATGAAGAACGCAGCAAAATGCGATAAGTAATGT GAATTGCAGAATTCAGTGAATCATCGAATCTTTGAACGCACAT TGCGCCCGCCAGTATTCTGGCGGGCATGCCTGTTCGAGCGTCA TTTCAACCCTCAAGCCCAGCTTGGTGTTGGGACTCGCGAGTCA AATCGCGTTCCCCAAATTGATTGGCGGTCACGTCGAGCTTCCA TAGCGTAGTAGTAAAACCCTCGTTACTGGTAATCGTCGCGGCC ACGCCGTTAAACCCCAACTTCTGAATGTTGACCTCGGATCAGG TAGGAATACCCGCTGAACTTAAGCATATCAATAGCCGGAGGA AACTCCAAACCCCCGGGAAAATACCAAATGGTGGCTCGGCGG AGACCGCCCGCCT
B03	ITS (ITS1)	GGGCTGGTGACCGGTCTACCACCGGGATGTTCATAACCCTTTG TTGTCCGACTCTGTTGCCTCCGGGGCGACCCTGCCTTCGGGCG GGGGCTCCGGGTGGACACTTCAAACTCTTGCGTAACTTTGCAG TCTGAGTAAACTTAATTAATAAATTAAAACTTTTAACAACGGA TCTCTTGGTTCTGGCATCGATGAAGAACGCAGCGAAATGCGAT AAGTAATGTGAATTGCAGAATTCAGTGAATCATCGAATCTTTG AACGCACATTGCGCCCCCTGGTATTCCGGGGGGCATGCCTGTT CGAGCGTCATTTCACCACTCAAGCCTCGCTTGGTATTGGGCAA CGCGGTCCGCCGCGTGCCTCAAATCGACCGGCTGGGTCTTCTG TCCCCTAAGCGTTGTGGAAACTATTCGCTAAAGGGTGCTCGGG AGGCTACGCCGTAAAACAAACCCATTTCTAAGGTTGACCTCGG ATCAGGTAGGGATACCCGCTGAACTTAAGCATATCAATAAGG CGGAGGAAGGTCACCCCGGGGGGGGTTAAAACCTTTGGTTGT CGAATTTTTGCCCCGGGGGGCCCCGGCCTCCGGGGGGGGGG TCGGGGGGGCACCTTTAAACCTGGGAAATTTTGGGGTCGGGG GAAACTTAATTAATAAATTAAAAAATTTTAAAACCGGAACCTT CGGGTCTTGGGGCCCTGGAAAAACGCCCCGAAAAGGCGCAAG TTAGTGTGGAATTGTGGGAAATTTGCTGGAAATCTTCCGAACC TTGAAGCCATTTGCCCGCTTTCTCCGTGGGAGGTGTTGTCCAA CGCTCTCTCTTGATATTGGGCAAACGGTGCCATGCTCAATGAC

		GGCTGGGTTCTTGTGCCTAACTTCACCATTCTAAGGGTCGGAG TACGTAAAATCAAGTAGCCAACGTGGTCGTCATGACACTGCGG AA
B05	ITS (ITS1)	GGGGGATCGGGACTTCACTCCAACCCCTGTGACATACCTATAC GTTGCCTCGGCGGATCAGCCCGCGCCCCGTAAAACGGGACGG CCCGCCCGAGGACCCCTAAACTCTGTTTTTAGTGGAACTTCTG AGTAAAACAAACAAATAAATCAAAACTTTCAACAACGGATCT CTTGGTTCTGGCATCGATGAAGAACGCAGCAAAATGCGATAA GTAATGTGAATTGCAGAATTCAGTGAATCATCGAATCTTTGAA CGCACATTGCGCCCGCCAGTATTCTGGCGGGCATGCCTGTTCG AGCGTCATTTCAACCCTCAAGCTCAGCTTGGTGTTGGGACTCG CGGTAACCCGCGTTCCCCAAATCGATTGGCGGTCACGTCGAGC TTCCATAGCGTAGTAATCATACACCTCGTTACTGGTAATCGTC GCGGCCACGCCGTAAAACCCCAACTTCTGAATGTTGACCTCGG ATCAGGTAGGAATACCCGCTGAACTTAAGCATATCAATAGTCG GAGGAATCCCTCCCCCCCCGGGGAAAAAAACTAT
B05	ß-TUBULIN (BT2)	GATTTCTCTCTGGCGAGCCGGTCTCGACAGCAATGGTGTTTAC AACGGTACCTCCGAGCTCCAGCTCGAGCGTATGAGCGTCTACT TCAACGAGGTTTGTTTCATCACTCCTGCCACGAAAACACAACA AGCTCACGCGCGCCTAGGCTTCCGGTAACAAGTATGTTCCCCG TGCCGTCCTCGTCGATCTCGAGCCCGGTACCATGGACGCCGTC CGTGCCGGTCCTTTCGGACAGCTTTTCCGTCCCGACAACTTCGT TTTCGGTCAATCCGGTGCCGGAAACAACTGGGCCAAGGGTCA ATACACTGAGGGTA
B06	ITS (ITS1)	GGGGATAGGGGCTCACTCCAAACCCCTGTGACATACCTATACG TTGCCTCGGCGGATCAGCCCGCGCCCCGTAAAACGGGACGGC CCGCCCGAGGACCCCTAAACTCTGTTTTTAGTGGAACTTCTGA GTAAAACAAACAAATAAATCAAAACTTTCAACAACGGATCTC TTGGTTCTGGCATCGATGAAGAACGCAGCAAAATGCGATAAG TAATGTGAATTGCAGAATTCAGTGAATCATCGAATCTTTGAAC GCACATTGCGCCCGCCAGTATTCTGGCGGGCATGCCTGTTCGA GCGTCATTTCAACCCTCAAGCTCAGCTTGGTGTTGGGACTCGC GGTAACCCGCGTTCCCCAAATCGATTGGCGGTCACGTCGAGCT

		TCCATAGCGTAGTAATCATACACCTCGTTACTGGTAATCGTCG CGGCCACGCCGTTAAACCCCAACTTCTGAATGTTGACCTCGGA TCAGGTAGGAATACCCGCTGAACTTAAGCATATCAATAGGCG GAGGAATCCC
B09	ITS (ITS1)	GGGGTAGTTTGATGCGGGCTGGATCTCTCGGGGTTACAGCCTT GCTGAATTATTCACCCTTGTCTTTTGCGTACTTCTTGTTTCCTTG GTGGGTTCGCCCACCACTAGGACAAACATAAACCTTTTGTAAT TGCAATCAGCGTCAGTAACAAATTAATAATTACAACTTTCAAC AACGGATCTCTTGGTTCTGGCATCGATGAAGAACGCAGCGAA ATGCGATAAGTAGTGTGAATTGCAGAATTCAGTGAATCATCGA ATCTTTGAACGCACATTGCGCCCTTTGGTATTCCAAAGGGCAT GCCTGTTCGAGCGTCATTTGTACCCTCAAGCTTTGCTTGGTGTT GGGCGTCTTGTCTCTAGCTTTGCTGGAGACTCGCCTTAAAGTA ATTGGCAGCCGGCCTACTGGTTTCGGAGCGCAGCACAAGTCGC ACTCTCTATCAGCAAAGGTCTAGCATCCATTAAGCCTTTTTTCA ACTTTTGACCTCGGATCAGGTAGGGATACCCGCTGAACTTAAG CATATCAATAGCCAGGATGAAACGGGCTGGAATCCTTTGGGGT ACCAGCCTTGCTGAATTATTTCACCCTGGTCCTTTTGCGTACTT TCTTGTTTCCCTTGGGTGGGGTCGGCCCACCCTAGGGACAAAA AAAAACTTTTGGTTATTTTCAATCCGCGTCCGCTACAAATTTTA TAAATTTCAATTTTCTCAAGAATTCGGTTTGTGGGCTCTGGAA AAAACGCACCAAGAGCAACAAATGGGGGGAGAGTGGGAGAA TTCTGTGAAATCACACATCTTTTTACCACCCCGCGCCCTGTGTT TGATCCAAAGGAGGAGCGTGTGCAGACCATGTTATCCACTCTC TGTGTCTGTGGGGGGGTCTGTGTCCTCATTCTTGTTGTGAAACT CCCTCTAAAATATTGGAAGCGCGTGTGTTTGTGCGAGCGCAGC TCTCTCATCCAGGTCTAGCATCCATTAGGCCTTTTTTCACATTA TGGACTCCGGATCAGTTAGGGATACCGCTGACTTTAGCTATCT AAGGGAGAGAAAAA
B11	ß-TUBULIN (BT2)	GTTAATCTTCTGGCGAGCCGGTCTCGACAGCAATGGTGTTTAC AACGGTACCTCCGAGCTCCAGCTCGAGCGTATGAGCGTCTACT TCAACGAGGTTTGTTTCATCACTCCTGCCACGAAAACACAACA AGCTCACGCGCGCCTAGGCTTCCGGTAACAAGTATGTTCCCCG

		TGCCGTCCTCGTCGATCTCGAGCCCGGTACCATGGACGCCGTC CGTGCCGGTCCTTTCGGACAGCTTTTCCGTCCCGACAACTTCGT TTTCGGTCAATCCGGTGCCGGAAACAACTGGGCCAAGGGTCAC TACACTGAGGGT
B11	ß- TUBUL IN (BT1)	AGGGCGTCTCCCTCATGACAGCCGAGGTGCTCACTCTTTCCGC GCTGTCAGCGTTCCTGAGCTGACCCAGCAGATGTTCGACCCCA AGAACATGATGGCTGCTTCCGACTTCCGCAACGGTCGTTACCT GACCTGTTCTGCCATCTTCCGTGGCCGCGTCGCCATGAAGGAG GTCGAGGACCAGATGCGCAACGTTCAGAACAAGAACTCATCT TATTTCGTCGAGTGGATCCCTAACAACATCCAGACCGCTCTCT GCGCTATTCCTCCTCGGGGACTTACTATGTCCTCTACCTTTATT GGAAACTCCACCTCTATCCAGGAGCTTTTCAAGCGTGTTGGCG AGCAGTTTACTGCTATGTTCCGACGCAAGGCTTTCTTGCATTG GTACACTGGTGAGGGTATGGACGAGATGGAGTTCACTGAGGC TGAGTTCAACAAGAACGATCTCATCA
B11	ITS (ITS1)	GGGGTCGGACTTACTCCAACCCCTGTGACATACCTATACGTTG CCTCGGCGGATCAGCCCGCGCCCCGTAAAACGGGACGGCCCG CCCGAGGACCCCTAAACTCTGTTTTTAGTGGAACTTCTGAGTA AAACAAACAAATAAATCAAAACTTTCAACAACGGATCTCTTG GTTCTGGCATCGATGAAGAACGCAGCAAAATGCGATAAGTAA TGTGAATTGCAGAATTCAGTGAATCATCGAATCTTTGAACGCA CATTGCGCCCGCCAGTATTCTGGCGGGCATGCCTGTTCGAGCG TCATTTCAACCCTCAAGCTCAGCTTGGTGTTGGGACTCGCGGT AACCCGCGTTCCCCAAATCGATTGGCGGTCACGTCGAGCTTCC ATAGCGTAGTAATCATACACCTCGTTACTGGTAATCGTCGCGG CCACGCCGTTAAACCCCAACTTCTGAATGTTGACCTCGGATCA GGTAGGAATACCCGCTGAACTTAAGCATATCAATAAACGGAG GAATTAATTCCCCACCCCCGGGG
B12	ß- TUBUL IN (BT2)	GAGTCTCTCTGGCGAGCCGGTCTCGACAGCATGGTGTTTACAA CGGTACCTCCGAGCTCCAGCTCGAGCGTATGAGCGTCTACTTC AACGAGGTTTGTTTCATCACTCCTGCCACGAAAACACAACAAG CTCACGCGCGCCTAGGCTTCCGGTAACAAGTATGTTCCCCGTG CCGTCCTCGTCGATCTCGAGCCCGGTACCATGGACGCCGTCCG

		TGCCGGTCCTTTCGGACAGCTTTTCCGTCCCGACAACTTCGTTT TCGGTCAATCCGGTGCCGGAAACAACTGGGCCAAGGGTCACT ACACTGAGGGTTACACCGAACGTGAAGAAGTCATTATGATCA ACCGAATTCTCCGAGACGATCCGGCCAAGGGTCACTACTCTGA GGGT
B12	ß-TUBULIN (BT1)	AAGCTCCCTCCTCAGAAAGCCGTGGTGCTCACTCTTTCCGCGC TGTCAGCGTTCCTGAGCTGACCCAGCAGATGTTCGACCCCAAG AACATGATGGCTGCTTCCGACTTCCGCAACGGTCGTTACCTGA CCTGTTCTGCCATCTTCCGTGGCCGCGTCGCCATGAAGGAGGT CGAGGACCAGATGCGCAACGTTCAGAACAAGAACTCATCTTA TTTCGTCGAGTGGATCCCTAACAACATCCAGACCGCTCTCTGC GCTATTCCTCCTCGGGGACTTACTATGTCCTCTACCTTTATTGG AAACTCCACCTCTATCCAGGAGCTTTTCAAGCGTGTTGGCGAG CAGTTTACTGCTATGTTCCGACGCAAGGCTTTCTTGCATTGGTA CACTGGTGAGGGTATGGACGAGATGGAGTTCACTGAGGCTGA GTTCAACATAAACGATCTCATC
B12	TEF (EF1)	ATCAACCCCGCCAGATGTGGCGGGGTAATTTCAACTTGAATAT TTGCTGACAAGATTGCATAGACCGGTCACTTGATCTACCAGTG CGGTGGTATCGACAAGCGAACCATCGAGAAGTTCGAGAAGGT TGGTTTCCATTTCCCCGATCGCACGCCGTCTACCCACCGATCCA TCAGTCGAATCAGTTACGACGATTGAATATGCGCCTGTTACCC CGCTCGAGTACAAAATTTTGCGGTTCAACCGTAATTTTTTTGGT GGGGTTTCAACCCCGCTACTCGAGCGACAGACGTTTGCCCTCT TCCCACAAACTCATGTCTCGTGCATCACGTGTCCATCAGCCAC TAACCACCCGACAATAGGAAGCCGCCGAGCTCGGTAAGGGTT CCTTCAAGTACGCCTGGGTTCTTGACAAGCTCAAGGCTGAGCG TGAGCGTGGTATCACCATCGATATCGCCCTCTGGAAGTTCGAG ACTCCTCGCTACTATGTCACCGTCATTGGTACGTTATCATCACT TACACTCAATACTTTCTCATGCTAACATGTACTTCAGACGCTCC CGGTCACCGTGATTTCATCAAGAACATGA
B12	ITS (ITS1)	GGGAATTCGGGCTCACTCCCAACCCCTGTGACATACCTATACG TTGCCTCGGCGGATCAGCCCGCGCCCCGTAAAACGGGACGGC CCGCCCGAGGACCCCTAAACTCTGTTTTAGTGGAACTTCTGA

		GTAAAACAAACAAATAAATCAAAACTTTCAACAACGGATCTC TTGGTTCTGGCATCGATGAAGAACGCAGCAAAATGCGATAAG TAATGTGAATTGCAGAATTCAGTGAATCATCGAATCTTTGAAC GCACATTGCGCCCGCCAGTATTCTGGCGGGCATGCCTGTTCGA GCGTCATTTCAACCCTCAAGCTCAGCTTGGTGTTGGGACTCGC GGTAACCCGCGTTCCCCAAATCGATTGGCGGTCACGTCGAGCT TCCATAGCGTAGTAATCATACACCTCGTTACTGGTAATCGTCG CGGCCACGCCGTTAAACCCCAACTTCTGAATGTTGACCTCGGA TCAGGTAGGAATACCCGCTGAACTTAAGCATATCAATATCGGA GGAAAAGCCCCCCACCCGGGGGAAAAAAATTTTTTTGCCCG GG
C1-1	ITS (ITS1)	TGGGGATCGGGCTTCACTCCCAACCCCTGTGACATACCTATAC GTTGCCTCGGCGGATCAGCCCGCGCCCCGTAAAACGGGACGG CCCGCCCGAGGACCCCTAAACTCTGTTTTTAGTGGAACTTCTG AGTAAAACAAACAAATAAATCAAAACTTTCAACAACGGATCT CTTGGTTCTGGCATCGATGAAGAACGCAGCAAAATGCGATAA GTAATGTGAATTGCAGAATTCAGTGAATCATCGAATCTTTGAA CGCACATTGCGCCCGCCAGTATTCTGGCGGGCATGCCTGTTCG AGCGTCATTTCAACCCTCAAGCTCAGCTTGGTGTTGGGACTCG CGGTAACCCGCGTTCCCCAAATCGATTGGCGGTCACGTCGAGC TTCCATAGCGTAGTAATCATACACCTCGTTACTGGTAATCGTC GCGGCCACGCCGTTAAACCCCAACTTCTGAATGTTGACCTCGG ATCAGGTAGGAATACCCGCTGAACTTAAGCATATCAATAAGG CGGAGGAA
C1-2	ß-TUBULIN (BT2)	AAGTATTCTCTGGCGGCCGGCCTCGACAGCAATGGTGTCTACA ACGGTACCTCCGAGCTCCAGCTCGAGCGCATGAGTGTCTACTT CAACGAGGTATGCCTTAACAGTCAATGCCAACGATCCACAAG CTCACACAACTAGGCCTCTGGCAACAAGTATGTTCCCCGAGCC GTCCTCGTCGATCTTGAGCCTGGTACCATGGACGCTGTCCGTG CTGGTCCCTTCGGTCAGCTCTTCCGTCCCGACAACTTCGTTTTC GGTCAGTCCGGTGCTGGAAACAACTGGGCCAAGGGTCACTAA ACTGAGGGTA

C1-2	ß-TUBULIN (BT1)	GGGTCCCTGCTCTCTGACAGCCGTGGTGCTCACTCTTTCCGCGCTGTCAGCGTTCCTGAGTTGACCCAACAGATGTTCGACCCCAAGAACATGATGGCTGCTTCGGACTTCCGCAACGGTCGCTACCTGACCTGCTCGGCCATTTTGTGAGTGATCCCGATTTTGCACATGGTAACAATTTACTGACTTTATCCAGCCGTGGCCGTGTCGCTATGAAGGAGGTCGAGGACCAGATGCGCAACGTCCAGAGCAAGAACTCGTCTTACTTCGTTGAATGGATTCCCAACAATATCCAGACAGCCCTTTGTGCCATCCCTCCCCGAGGACTTACGATGTCTTCGACCTTCATCGGAAACTCCACCTCTATCCAGGAGCTCTTCAAGCGCGTTGGTGAGCAGTTCACTGCCATGTTCCGACGCAAGGCTTTCTTGCATTGGTATACTGGTGAGGGTATGGACGAGATGGAGTTCACTGAGGCTGAGTTCAACATGAACGATCTCATCA
C1-2	TEF (EF1)	ACTCTGGCAGTCGACCACTGTGAGTACTACCCTGGACGATGAGCTTATCTGCCATCGTGATCCTGACCAAGATCTGGCGGGTACATCTTGGAAGACAATATGCTGACATCGCTTCACAGACCGGTCACTTGATCTACCAGTGCGGTGGTATCGACAAGCGAACCATCGAGAAGTTCGAGAAGGTTAGTCACTTTCCCTTCGATCGCGCGTCCTCTGCCCACCGATTTCACTTGCGATTCGAAACGTGCCTGCTACCCCGCTCGAGACCAAAAATTTTGCGATATGACCGTAATTTTTTTGGTGGGGCATTCACCCCGCCACTCGAGCGATGGGCGCGTTTTTGCCCTCTCCTGTCCACAACCTCAATGAGCGCATTGTCACGTGTCAAGCAGCGACTAACCATTCGACAATAGGAAGCCGCTGAGCTCGGTAAGGGTTCCTTCAAGTACGCCTGGGTTCTTGACAAGCTCAAGGCCGAGCGTGAGCGTGGTATCACCATCGATATTGCTCTCTGGAAGTTCGAGACTCCTCGCTACTATGTCACCGTCATTGGTATGTTGTCGCTCATACCTCATCCTACTTCCTCATACTAACACATCATTCAGACGCTCCCGGTCACCGTGATTTAATCA
C1-2	ITS (ITS1)	TGTGGTGGCGACGCCTGGTCTCTAAGGCAGGACGCGACCAAATGTTGGGTCGACGGATCAGCCTTGTCCCGGTGAAACGGGACGGCCCCCCAGAGGACCCCTACCCTCTGTTTCTATATGTAACTTCTGATGAAAACCCTAACTACGTCAAAACTTTCATCAACGGATCTCTTGGTTCTGGCATCTATGAAGAACCCAGCATAATGCAATAAGTAATGTGAATGGCATAATTCATTGAATCATCGAATCTTTGAGCAC

		ACTTTGCGCCCTCCAGTATTCTGGCGGGCTTGCCTGTTCCAGCG TCATTTCCACCCTCAAGCCCCCTGGTTTGGTGTTGGGGATCGA CGAGCCCTTGCGGCTGGCTGGCCCCGTGCTGGAGTGGCGGCCT CCCTGCATCTTCCATTGTCCAACTGGATTCCCCTCGCAACTGGT ACTCGGCTCGGCCAAACCGATAAACCCCCAACTTTTGAATGTT GTCCTCGCTTTAGGTAGGAAAACCCGTTGTAATTAATCTTAAC CATTAGCGTAGAATTTTCCTGAGGAAATTCTCTCTAAG
C1-3	ITS (ITS1)	CGGGCCCGCTTACCTTTCCCTTTCATTCGCCTATGCCCGTACCA AATTGTTGCCTCGGCGGATCAGCCCGCTCCCGGTAAAACGGGA CGGCCCGCCAGAGGACCCCTAAACTCTGTTTCTATATGTAACT TCTGAGTAAAACCATAAATAAATCAAAACTTTCAACAACGGAT CTCTTGGTTCTGGCATCGATGAAGAACGCAGCAAAATGCGATA AGTAATGTGAATTGCAGAATTCAGTGAATCATCGAATCTTTGA ACGCACATTGCGCCCGCCAGTATTCTGGCGGGCATGCCTGTTC GAGCGTCATTTCAACCCTCAAGCCCCCGGGTTTGGTGTTGGGG ATCGACGAGCCCTTGCGGCAAGCCGGCCCCGAAATCTAGTGG CGGTCTCGCTGCAGCTTCCATTGCGTAGTAGTAAAACCCTCGC AACTGGTACGCGGCGCGGCCAAGCCGTTAAACCCCCAACTTCT GAATGTTGACCTCGGATCAGGTAGGAATACCCGCTGAACTTAA GCATATCAATAAGCGGAGGAATTTTTTTTTTTTTTTTATTCCT TTCTTTTTAATTCATTTTTTTTTCTGCTGATCTTCTTTCCTGTTAC TTTATTTTCCTGAGTACTTATTTTTTTTTTTC
C1-4	ß-TUBULIN (BT1)	GAGGGGCCTCCTCTCTCTGGAGTGGCTCGCACGCCTTCAGCGC CGTTTCCGTCCCCGAGCTCACTCAGCAGCTCTTCGATCCCAAG AACATGATGGCCGGTTCCGATTTCCGCAACGGCCGTTACCTCA CCTGCTCCGCCATCTTCCGCGGTCGCGTTTCCGCCAAGGAGGT TGAGGATCAGATGCGCAACGTTCAGCAGAAGAACTCTGCCTA CTTCGTTGAGTGGATTCCCAACAACGTTCAGACCACTCTGTGC TCTGTTCCTCCCAAGGGTCTCAAGATCTCTTCCACTTTCGTCGG AAACTCGACTGCTATCCAGGAGATCTTCAAGCGTGTTGGTGAG CAGTTCACCGCCATGTTCCGTCGCAAGGCTTTCTTGCATTGGTA CACTGGCGAGGGTATGGATGAGATGGAATTCACCGAGGCTGA GTTCAACATGAACGATCTCGTC

C1-4	ITS (ITS1)	GGGGCCTCGGAGAATCACTCATCACCCTGTGACATACCTAAAC GTTGCTTCGGCGGGAATAGACGGCCCCGTGAAACGGGCCGCC CCCGCCAGAGGACCCTTAACTCTGTTTCTATAATGTTTCTTCTG AGTAAAACAAGCAAATAAATTAAAACTTTCAACAACGGATCT CTTGGCTCTGGCATCGATGAAGAACGCAGCGAAATGCGATAA GTAATGTGAATTGCAGAATTCAGTGAATCATCGAATCTTTGAA CGCACATTGCGCCCGCCAGTATTCTGGCGGGCATGCCTGTTCG AGCGTCATTACAACCCTCAGGCCCCCGGGCCTGGCGTTGGGGA TCGGCGGAGCCCTTTGTGGGCACACGCCGTCCCCCAAATACGG TGGCGGTCCCGCCGCAGCTTCCATCGCGTATTACCTAGCACCT CGCGAGTGGAGAGGGGGGCGGCCACGCCAGAAAACACCCAAC TCTTCTGAGGTTGACCTCGAATCAGGGATGGTAGCCGATGAAC TTAGCATAAAGAAGAGAAAAAGAAATTATCGAAGTATCACCT GGCAACCATAAAAAACACTTTTTTCTGTGGGTAA
C1-5	ß-TUBULIN (BT1)	GGGCGGCCTCCTCATGACAGCCGTGGTGCTCACTCTTTCCGCG CTGTCAGCGTTCCTGAGCTGACCCAGCAGATGTTCGACCCCAA GAACATGATGGCTGCTTCCGACTTCCGCAACGGTCGTTACCTG ACCTGTTCTGCCATTTTCCGTGGCCGCGTCGCCATGAAGGAGG TCGAGGACCAGATGCGCAACGTTCAGAACAAGAACTCATCTT ACTTCGTCGAGTGGATCCCTAACAACATCCAGACCGCTCTCTG CGCTATTCCTCCTCGGGGACTTACTATGTCCTCTACCTTTATTG GAAACTCCACCTCTATCCAGGAGCTTTTCAAGCGTGTTGGCGA GCAGTTTACTGCTATGTTCCGACGCAAGGCTTTCTTGCATTGGT ACACTGGTGAGGGTATGGACGAGATGGAGTTCACTGAGGCTG AGTTCAACATGAACGATCTCATCA
C1-5	ITS (ITS1)	GGGGGTCGACTCACTCCAACCCCTGTGACATACCTATACGTTG CCTCGGCGGATCAGCCCGCGCCCCGTAAAACGGGACGGCCCG CCCGAGGACCCCTAAACTCTGTTTTAGTGGAACTTCTGAGTA AAACAAACAAATAAATCAAAACTTTCAACAACGGATCTCTTG GTTCTGGCATCGATGAAGAACGCAGCAAAATGCGATAAGTAA TGTGAATTGCAGAATTCAGTGAATCATCGAATCTTTGAACGCA CATTGCGCCCGCCAGTATTCTGGCGGGCATGCCTGTTCGAGCG TCATTTCAACCCTCAAGCTCAGCTTGGTGTTGGGACTCGCGGT

		AACCCGCGTTCCCCAAATCGATTGGCGGTCACGTCGAGCTTCC ATAGCGTAGTAATCATACACCTCGTTACTGGTAATCGTCGCGG CCACGCCGTTAAACCCCAACTTCTGAATGTTGACCTCGGATCA GGTAGGAATACCCGCTGAACTTAAGCATATCAATAGGCGGAG GA
C2-1	ITS (ITS1)	GGGGCAGGAACTAGCTCTATACCCTTTGTGACATACCTATAAC TGTTGCTTCGGCGGGTAGGGTCTCCGTGACCCTCCCGGCCTCC CGCCCCCGGGCGGGTCGGCGCCCGCCGGAGGATAACCAAACT CTGATTTAACGACGTTTCTTCTGAGTGGTACAAGCAAATAATC AAAACTTTTAACAACGGATCTCTTGGTTCTGGCATCGATGAAG AACGCAGCGAAATGCGATAAGTAATGTGAATTGCAGAATTCA GTGAATCATCGAATCTTTGAACGCACATTGCGCCCGCCAGCAT TCTGGCGGGCATGCCTGTTCGAGCGTCATTTCAACCCTCAAGC TCTGCTTGGTGTTGGGGCCCTACAGCTGATGTAGGCCCTCAAA GGTAGTGGCGGACCCTCCCGGAGCCTCCTTTGCGTAGTAACTT TACGTCTCGCACTGGGATCCGGAGGGACTCTTGCCGTAAAACC CCCAACTTTCCAAAGGTTGACCTCGGATCAGGTAGGAATACCC GCTGAACTTAAGCATATCAATAAGACGGAGGAAGCCTTTTTAA CCCTTGGTAAAAAACCCTAAAAATGTTGGTTTCGCGGGGGAGG GGTTCCCGGTACCCTCCGCCCCCCCCCGGGGGGGGTCGGCCC CCCGAAAAAAAAAAAAAATAGGAATTAACAATTTCTTCTCTG GATGGGGGGGGGGAATATGTAATGTGTTACGGGGAACTAGGG TGTTGTGGGTTTTTAGAAGAGCGCTAGTGCAGGGGATCGGGTG AGTGGAAAATTCGTGAATCCTGACTCTTTTAATACATTGGCCC CGCGGGGGCGTGCGGTACAAGACGCTTGCCCGATGGCTTGTG GGGCCGGGGGGGACAATCACGCAATGCAGCCACGAGTGACTG GAGCAGCCGGCACGACCCCTTTGATCGGAATCGTTTCCACTGC ACGACGCGTGCCAAGACCCCACTGTCCTAGGATCACCTCGGAT GGGTAGGATATCCCCCTGACCTAAGCCAATCTATCCGAGAGAA AC
C2-1	ApMat (AMf)	GCAGTCTGCAGTGGCGAAGAGCATCATATGGGCGATTCAATG GTCCTCATGGCGGGGGGCAAAAGACACTCTAGGTATCGGGCT GGAATAGATGGTCTATGAAGATGATATTTACTGGCTTGCAGAT

		TATAATTACAGAGAAAGATTCGGGTTCGCTCTGAACACGCGAA TACATGGGTTGTGGATACATTTTTCCACCAATATGTTCATTAAA TCGAAGATCCCTGGTTCGCGTTGCCATCGAAGCAGATGGGCCA GGATGATTCTTGGTTCGTCAGATCCGATGACCTCCTAGCATTCT TACGTCTAAGTTTCGCCGCACAAAGGCCCGTTGGTTTCTGGCG CAGGGTAGCTCTTGCCGCAGCATGCGAGAAAGGGAATCGATG ACCAGATGCGTGGTCGCCTCCTGGGTCACGTTGACTGGATAGA GATCGAAGACAGCCGCAAAAGGCGCCACATTCTGAGGCTCCT CTGATCGCTGATGCTGCCAGTCTAG
C2-2	ß-TUBULIN (BT2)	AGTTCCCTTCTCTGGCGAGCACGGCCTCGACAGCATGGTGTCT ACAACGGTACCTCCGAGCTCCAGCTCGAGCGCATGAGTGTCTA CTTCAACGAGGTATGCATTAACAGTCAATGCCAATAATTCCCA AGCTCACACAACTAGGCCTCTGGCAACAAGTATGTTCCCCGAG CCGTCCTCGTCGATCTTGAGCCTGGTACCATGGACGCCGTCCG TGCTGGTCCCTTTGGTCAGCTCTTCCGTCCCGACAACTTCGTTT TCGGTCAGTCCGGTGCTGGAAACAACTGGGCCAAGGGTCACT ACACTGAGGGTA
C2-2	TEF (EF1)	ACTCTGGCAGTCGACCACTGATGAGTACTACCCTCGATGATGA GCTTATCTGCCATCGAAACCCTCACCAAGACCTGGCGGGGTAT TCCTCTTGAAACAAGATGCTGACATGGCTACACAGACCGGTCA CTTGATCTACCAGTGCGGTGGTATCGACAAGCGAACCATCGAG AAGTTCGAGAAGGTTAGTCACTTTCCCTTCGATCGCGCGTCCT TTGTACATCGATTTCCCCTACGACTCGAAACGTGCCCGCTACC CCGCTCGAGACCAAAAATTTTGCGATATGACCGTAATTTTTTT GGTGGGGCATTTACCCCGCCACTCGAGCGATGGGCGCGTTTTT GCCCTTTCCTAGCCACAACTTCAATGAGCGCATCATCACGTGT CAAGCAGTCACTAACCATCTGACAATAGGAAGCCGCTGAGCT CGGTAAGGGTTCCTTCAAGTACGCCTGGGTTCTTGACAAGCTC AAGGCCGAGCGTGAGCGTGGTATCACCATCGATATTGCTCTCT GGAAGTTCGAGACTCCCCGCTACTATGTCACCGTCATTGGTAT GTTGTCGCTCATGCCTCACTCTATTTCCTAGTACTAACATGTCA CTCAGACGCTCCCGGTCACCGTGACTTCATAAAAA

C2-2	ITS (ITS1)	CGTCTGTTGGCTTCTCTGCCATTCCCCTGTGCACGTACCAAATG TTGCCTCGGCGGATCAGCCCGCTCCCGGTAAAACCGGACGGCC CGCCAGAGGACCCCCAAACTCTGTTTCTATATGTAACTTCTGA GTAAAACCATAAATAAATCAAAACTTTCAACAACGGATCTCTT GGTTCTGGCATCGATGAAGAACGCAGCAAAATGCGATAAGTA ATGTGAATTGCAGAATTCAGTGAATCATCGAATCTTTGAACGC ACATTGCGCCCGCCAGTATTCTGGCGGGCATGCCTGTTCGAGC GTCATTTCAACCCTCAAGCCCAGCTTGGTGTTGGGACTCGCGA GTCAAATCGCGTTCCCCAAATTGATTGGCGGTCACGTCGAGCT TCCATAGCGTAGTAGTAAAACCCTCGTTACTGGTAATCGTCGC GGCCACGCCGTTAAACCCCAACTTCTGAATGTTGACCTCGGAT CAGGTAGGAATACCCGCTGAACTTAAGCATATCAATAAGCGG AGAAATTTTCTACCCAGTTAAAACTT
C2-3	ITS (ITS1)	GAGCATGCAGCAATCGTCTCATTTAGGGGAAGACCAATTGTTG AGGGAACGGATCATCCCGCTCCCGGTAAAACGGGACGGACCG CCAGAGGACCCCTAAACTCTGTTTCTATATGTAACCTCTGAGT AAAACCATAAATAAATCAAAACTTTCAACAACGGATCTCTTGG TTCTGGCATCGATGAAGAACGCAGCAAAATGCGATAAGTAAT GTGAATTGCATAATTCAGTGAATCATCTAATCTTTGAACGCAC ATTGCGCCCGCCAGTATTCTGGCGGGCATGCCTGTTCGAGCGT CATTTCAACCCTCAAGCCCCCGGGTTTGGTGTTGGGGATTGGC GAGCCCTTTTTGTTTGTCGGTCCTTAAATCTTTGGCTTTTTCTCT GCATTTTC
C2-4	ß-TUBULIN (BT2)	GTTTTCTCTCTGGCGAGCCGGCCTCGACAGCAATGGTGTCTAC AACGGTACCTCCGAGCTCCAGCTCGAGCGCATGAGTGTCTACT TCAACGAGGTATGCATTAACAGTCAATGCCAATAATTCCCAAG CTCACACAACTAGGCCTCTGGCAACAAGTATGTTCCCCGAGCC GTCCTCGTCGATCTTGAGCCTGGTACCATGGACGCCGTCCGTG CTGGTCCCTTTGGTCAGCTCTTCCGTCCCGACAACTTCGTTTTC GGTCAGTCCGGTGCTGGAAACAACTGGGCCAAGGGTCACTAC ACTGAGGGTA
C2-4	ITS	GGGGGCTCGGGCTTCACTCCAACCCCTGTGACATACCAATTGT TGCCTCGGCGGATCAGCCCGCTCCCGGTAAAACGGGACGGCC

	(ITS1)	CGCCAGAGGACCCCCAAACTCTGTTTCTATATGTAACTTCTGA GTAAAACCATAAATAAATCAAAACTTTCAACAACGGATCTCTT GGTTCTGGCATCGATGAAGAACGCAGCAAAATGCGATAAGTA ATGTGAATTGCAGAATTCAGTGAATCATCGAATCTTTGAACGC ACATTGCGCCCGCCAGTATTCTGGCGGGCATGCCTGTTCGAGC GTCATTTCAACCCTCAAGCCCAGCTTGGTGTTGGGACTCGCGA GTCAAATCGCGTTCCCCAAATTGATTGGCGGTCACGTCGAGCT TCCATAGCGTAGTAGTAAAACCCTCGTTACTGGTAATCGTCGC GGCCACGCCGTTAAACCCCAACTTCTGAATGTTGACCTCGGAT CAGGTAGGAATACCCGCTGAACTTAAGCATATCAATAAGGCG GAGGAA
C2-4	TEF (EF1)	ACCACTGTGAGTACTACCCTCGATGATGAGCTTATCTGCCATC GAAACCCTCACCAAGACCTGGCGGGGTATTCCTCTTGAAACAA GATGCTGACATGGCTACACAGACCGGTCACTTGATCTACCAGT GCGGTGGTATCGACAAGCGAACCATCGAGAAGTTCGAGAAGG TTAGTCACTTTCCCTTCGATCGCGCGTCCTTTGTACATCGATTT CCCCTACGACTCGAAACGTGCCCGCTACCCCGCTCGAGACCAA AAATTTTGCGATATGACCGTAATTTTTTTGGTGGGGCATTTACC CCGCCACTCGAGCGATGGGCGCGTTTTTGCCCTTTCCTAGCCA CAACTTCAATGAGCGCATCATCACGTGTCAAGCAGTCACTAAC CATCTGACAATAGGAAGCCGCTGAGCTCGGTAAGGGTTCCTTC AAGTACGCCTGGGTTCTTGACAAGCTCAAGGCCGAGCGTGAG CGTGGTATCACCATCGATATTGCTCTCTGGAAGTTCGAGACTC CCCGCTACTATGTCACCGTCATTGGTATGTTGTCGCTCATGCCT CACTCTATTTCCTAGTACTAACATGTCACTCAGACGCTCCCGGT CACCGTGACTTCAACAAA
C2-4	ITS (ITS1)	GGGGGCTCGGGCTTCACTCCAACCCCTGTGACATACCAATTGT TGCCTCGGCGGATCAGCCCGCTCCCGGTAAAACGGGACGGCC CGCCAGAGGACCCCCAAACTCTGTTTCTATATGTAACTTCTGA GTAAAACCATAAATAAATCAAAACTTTCAACAACGGATCTCTT GGTTCTGGCATCGATGAAGAACGCAGCAAAATGCGATAAGTA ATGTGAATTGCAGAATTCAGTGAATCATCGAATCTTTGAACGC ACATTGCGCCCGCCAGTATTCTGGCGGGCATGCCTGTTCGAGC

		GTCATTTCAACCCTCAAGCCCAGCTTGGTGTTGGGACTCGCGA GTCAAATCGCGTTCCCCAAATTGATTGGCGGTCACGTCGAGCT TCCATAGCGTAGTAGTAAAACCCTCGTTACTGGTAATCGTCGC GGCCACGCCGTTAAACCCCAACTTCTGAATGTTGACCTCGGAT CAGGTAGGAATACCCGCTGAACTTAAGCATATCAATAAGGCG GAGGAA
C3-1	ITS (ITS1)	AGGGGCTGGATTCGCTCTGCACCCTTTGTGACATACCTATAAC TGTTGCTTCGGCGGGTAGGGTCCCCGTGACCCTCCCGGCCCCC CGCCCCCGGGCGGGTCGGCGCCCGCCGGAGGATAACCAAACT CTGATTTGACGACGTTTCTTCTGAGTGGTACAAGCAAATAATC AAAACTTTTAACAACGGATCTCTTGGTTCTGGCATCGATGAAG AACGCAGCGAAATGCGATAAGTAATGTGAATTGCAGAATTCA GTGAATCATCGAATCTTTGAACGCACATTGCGCCCGCCAGCAT TCTGGCGGGCATGCCTGTTCGAGCGTCATTTCAACCCTCAAGC TCTGCTTGGTGTTGGGGCCCTACAGCAGATGTAGGCCCTCAAA GGTAGTGGCGGACCCTCCCGGAGCCTCCTTTGCGTAGTAACTT TACGTCTCGCACTGGGATCCGGAGGGACTCTTGCCGTAAAACC CCCCAATTTTCCAAAGGTTGACCTCGGATCAGGTAGGAATACC CGCTGAACTTAAGCATATCAATAAGTCGGAGGAAGGCCTTTGG AACCCTTGGGAAAAAAAACAATAATTGTGGGTTGGGGGGGTT GGGGGCCCGGACCCCCGGGCCCCCCCCCCGGGGGGCGGGGG CCCCCCGAAGAAAAAAAAATGTTGATTTGACAACTTTTCTGTC AATGGGAAGAGGGAAAAAATTAAATTTTTTATACGGAGATGT GGGTTGTGGGCCGGAAAGAAACGCCCAAAGCAGGAGAAGGG GGATCTGTGAGAAGATCGGTGAAACTCAATTTTGAAAGCAGG CGGCCCCGCGGGCGGGCGGGACAAAGATGATCGACCAGGTCT GTCGGTTGTGCGGGGCCTCGGCCAAAGTCGCATCTGTGTGTTG GGGAAAGCGCGCGGGCACCTCTTTGTGGAATGATCTACGTTGC GCAACTGGGCTGAAACACCAGCGTCGCCCTGGGAGACCTCCG CATAAGGGGAGATGACTACCCCTTGAACATTTAACGAAATCAT GTAACGCGGGGAGGAGGACT
C3-1	ApMat (AMf)	GGGAGGAGTGGAGATGCGGGACGTTCATCTGGAGCAGCGACT GGAAAAAAGATCAGACCTAGTTATTCACGTGATGCGCAGTCG

		AGACAGTGGCTGGGCATCATGGATGTGTTGGCAGTCTGCAGTG GCGAAGAGCAACGTGTGGGCGAATCAATGGTCCTCATGGCGG GGGGTAAAAGACACTCTAGGTATCGGGCTGGAATAGATGTTC CATGAAGAGGATATTTACTGGCTTGCAGATTGTAATTACAGAA AAAGATTCGTGTTCGCTTGACATGCGAATACATGGGTTGTGAG TACATTTTTCCACCAATATGGTCATCAAATCGAAGATCTCTGCT TCGCGTTGCCATCGAAGCAGATGGTCCAGGATGATTCTTGGTT CCTCAGATCCGGTGATCTCCTAGCGTTCGCACGTCGAAGTATC GCCGCACAAAGGTCTGTTGGTTTCTCGCGCAGGTAACTCTTGC CACAGCATGCGGGAAGTGAATCGACGACCAGGTGCGCGGTCG CCTCCTGGGTCACGCTGACTGGATAGAGATCGAAGACAGCCTC CAAAGGCGCCATGTTCTGAGGCTCCTCTGGTCGCTGATGCTGC CAGTCTAGAACACAAGGACGACCTAGAGTCGTCTGGCAGCGC CGATATCTATTCAGTTCCATGACTGATACTACAGCGAATTTTC GCAGTCGGTAG
C3-2	ITS (ITS1)	TTGGCCTCGGGGGTTCACTCCCACCCCCTGTGACATACCAATT GTTGCCTCGGCGGATCAGCCCGCTCCCGGTAAAACGGGACGG CCCGCCAGAGGACCCCCAAACTCTGTTTCTATATGTAACTTCT GAGTAAAACCATAAATAAATCAAAAGTTTTACCCGGTTTTATT GTGTTTGTATCAAATTTTCTTATTTTTATATAATGCAACAAAAC TTGATTTTTTTAATATTTATATTAATTTTTTTAATTATTATTATT TTATATCCTAATTTTAATTTTGTGAACAATCTTTCTTAAAAATT TTATACATTTTTTTTTAATTTATTTCTATTTATATATTTTTTTTT TTTTTTTTTTTGTTTTTTTTTTTTTTTTTTCATTTTTATTTTATTTT TTTTTTAAATCCCACTTTTGATGTTACCCCCGATAGGGGGGAAT ACCCCCCGAAATTAAGCCTTCAAAAGCGCCGCAGGAAGTTCTT TTTTTTTTTTTTTTTTTTTTTTTTTTTTTTTTTTTTTTTAAAAAAAAA ATAATTAAAATCAAAAGAAAAATAAAAAAAAATAATAAAAAA AAAAATAAAATTTTAAAATTTT
C4-1	ITS (ITS1)	TTGGCCTCGGGGGTTCACTCCCACCCCCTGTGACATACCAATT GTTGCCTCGGCGGATCAGCCCGCTCCCGGTAAAACGGGACGG CCCGCCAGAGGACCCCCAAACTCTGTTTCTATATGTAACTTCT GAGTAAAACCATAAATAAATCAAAAGTTTTACCCGGTTTTATT

		GTGTTTGTATCAAATTTTCTTATTTTATATAATGCAACAAAAC TTGATTTTTTTAATATTTATATTAATTTTTTTAATTATTATTATT TTATATCCTAATTTTAATTTTGTGAACAATCTTTCTTAAAAATT TTATACATTTTTTTTTAATTTATTTTCTATTTATATATTTTTTTTT TTTTTTTTTTTGTTTTTTTTTTTTTTTTTTCATTTTTATTTTATTTT TTTTTTAAATCCCACTTTTGATGTTACCCCCGATAGGGGGGAAT ACCCCCCGAAATTAAGCCTTCAAAAGCGCCGCAGGAAGTTCTT TTTTTTTTTTTTTTTTTTTTTTTTTTTTTTTTTTTTTTTAAAAAAAAA ATAATTAAAATCAAAAGAAAAATAAAAAAAAATAATAAAAAA AAAAATAAAATTTTAAAATTTT
C4-2	ITS (ITS1)	GGGCCCGAGTTCGCTCTGCACCCTTTGTGACATACCTATAACT GTTGCTTCGGCGGGTAGGGTCCCCGTGACCCTCCCGGCCCCCC GCCCCCGGGCGGGTCGGCGCCCGCCGGAGGATAACCAAACTC TGATTTGACGACGTTTCTTCTGAGTGGTACAAGCAAATAATCA AAACTTTTAACAACGGATCTCTTGGTTCTGGCATCGATGAAGA ACGCAGCGAAATGCGATAAGTAATGTGAATTGCAGAATTCAG TGAATCATCGAATCTTTGAACGCACATTGCGCCCGCCAGCATT CTGGCGGGCATGCCTGTTCGAGCGTCATTTCAACCCTCAAGCT CTGCTTGGTGTTGGGGCCCTACAGCAGATGTAGGCCCTCAAAG GTAGTGGCGGACCCTCCCGGAGCCTCCTTTGCGTAGTAACTTT ACGTCTCGCACTGGGATCCGGAGGGACTCTTGCCGTAAAACCC CCCAATTTTCCAAAGGTTGACCTCGGATCAGGTAGGAATACCC GCTGAACTTAAGCATATCAATAAACGGAGGAATCCTTGGGAC CTTTGGTGGAAAAAATTAAAAATTGTGCTGGGGGGGTGGGGG GGGGTCTGCGCCCCCCCCCCCGGGGGGGGGGGGGGCCCGGTG AAAAAGAAAAAAAAGGAATGGAAAAATCTTTCTGGTGGTGGG GCGGGAAAAACTCTAGTTTTTCTGCCATTTTTGGGTGTGTCTGG TACAGAAAAGAAACCGAAACG
C4-3	ß-TUBULIN (BT2)	AGTACTCTCTGGCGAGCCGGCCTCGACAGCAATGGTGTCTACA ACGGTACCTCCGAGCTCCAGCTCGAGCGCATGAGTGTCTACTT CAACGAGGTATGCCTTAACAGTCAATGCCAACGATCCACAAG CTCACACAACTAGGCCTCTGGCAACAAGTATGTTCCCCGAGCC GTCCTCGTCGATCTTGAGCCTGGTACCATGGACGCTGTCCGTG

		CTGGTCCCTTCGGTCAGCTCTTCCGTCCCGACAACTTCGTTTTC GGTCAGTCCGGTGCTGGAAACAACTGGGCCAAGGGTCACTAC ACTGAGGGTA
C4-3	ß-TUBULIN (BT1)	CGCTTAAGCCACCAACTCGACTTTTTTTCGGGACAAGTGAATT GTTGTGCGGATTTTTTTTTTTTGTGTTGAGGTGGGGAAGGAAG GGGGTGTGTTTTTGTTTGTTTTTTTCCTGGCAGGGGGGT
C4-3	TEF (EF1)	ACAGTGAGTACTACCCTGGACGATGAGCTTATCTGCCATCGTG ATCCTGACCAAGATCTGGCGGGGTACATCTTGGAAGACAATAT GCTGACATCGCTTCACAGACCGGTCACTTGATCTACCAGTGCG GTGGTATCGACAAGCGAACCATCGAGAAGTTCGAGAAGGTTA GTCACTTTCCCTTCGATCGCGCGTCCTCTGCCCACCGATTTCAC TTGCGATTCGAAACGTGCCTGCTACCCCGCTCGAGACCAAAAA TTTTGCGATATGACCGTAATTTTTTTGGTGGGGCATTTACCCCG CCACTCGAGCGATGGGCGCGTTTTTGCCCTTTCCTGTCCACAA CCTCAATGAGCGCATTGTCACGTGTCAAGCAGCGACTAACCAT TCGACAATAGGAAGCCGCTGAGCTCGGTAAGGGTTCCTTCAAG TACGCCTGGGTTCTTGACAAGCTCAAGGCCGAGCGTGAGCGTG GTATCACCATCGATATTGCTCTCTGGAAGTTCGAGACTCCTCG CTACTATGTCACCGTCATTGGTATGTTGTCGCTCATACTTCATC CTACTTCCTCATACTAACACATCATTCAGACGCTCCCGGTCAC CGTGATTTCATCAAGAACATGATCACTGGTACTTCCC
C4-3	ITS (ITS1)	TCCGCGGGGAAATTTGGGGACGGGCTCTCCTGGTGTCATGAAT AAAAGGGGGCCTCGGGTTGATCAGACGGCTCCCGGTAAAATG GGTCCCTTTTCACAGGACCCTAGAACTGTTCATAGCCCTTTTAA GGAGG
C4-4	ß-TUBULIN (BT1)	GTGTTAAGGGGCGAACTGTATTTTTCTATGGGACAGGGGTATT TGTTGGGGGGGTTTTTCTTCGCGGGGGGATGGAGGGCTGGG GGTCTTGGTGTGTTTCGTTGGTAAAGGAGGGT
C4-4	ß-TUBUL	AGCCGCCTTGCTCTCTGACAGCCGTGGTGCTCACTCTTTCCGCG CTGTCAGCGTTCCTGAGTTGACCCAACAGATGTTCGACCCCAA

	IN (BT2)	GAACATGATGGCTGCTTCGGACTTCCGCAACGGTCGCTACCTG ACCTGCTCGGCCATTTTGTGAGTGATCCCGATTTTGCACATGGT AACAATTTACTGACTTTATCCAGCCGTGGCCGTGTCGCTATGA AGGAGGTCGAGGACCAGATGCGCAACGTCCAGAGCAAGAACT CGTCTTACTTCGTTGAATGGATTCCCAACAATATCCAGACAGC CCTTTGTGCCATCCCTCCCCGAGGACTTACGATGTCTTCGACCT TCATCGGAAACTCCACCTCTATCCAGGAGCTCTTCAAGCGCGT TGGTGAGCAGTTCACTGCCATGTTCCGACGCAAGGCTTTCTTG CATTGGTATACTGGTGAGGGTATGGACGAGATGGAGTTCACTG AGGCTGAGTTCAACATGAACGATCTCATCA
C4-4	ITS (ITS1)	GGGGTCGGACTTAACTCCAACCCCTGTGACATACCAATTGTTG CCTCGGCGGATCAGCCCGCTCCCGGTAAAACGGGACGGCCCG CCAGAGGACCCCTAAACTCTGTTTCTATATGTAACTTCTGAGT AAAACCATAAATAAATCAAAACTTTCAACAACGGATCTCTTGG TTCTGGCATCGATGAAGAACGCAGCAAAATGCGATAAGTAAT GTGAATTGCAGAATTCAGTGAATCATCGAATCTTTGAACGCAC ATTGCGCCCGCCAGTATTCTGGCGGGCATGCCTGTTCGAGCGT CATTTCAACCCTCAAGCCCCCGGGTTTGGTGTTGGGGATCGGC GAGCCCTCGCGGCAAGCCGGCCCCGAAATCTAGTGGCGGTCTC GCTGCAGCTTCCATTGCGTAGTAGTAAAACCCTCGCAACTGGT ACGCGGCGCGGCCAAGCCGTTAAACCCCCAACTTCTGAATGTT GACCTCGGATCAGGTAGGAATACCCGCTGAACTTAAGCATATC AATAGGCGGAGGAA
C4-5	ß-TUBULIN (BT1)	CATTATCCGGAGCAGCACTATTCACGAGAGAAGAACAATTAG GTGAGGGATTTACGGCAGCGAGGAAAAAGGAGGGGGCTGCGA GTTTGAAATCGTTTTAGAAAAAGAAAGGAAACCATAATTAAA CAAACTTTCAACACTGATTCTTGGTTCTGGTTTTTTTATTAAC GTTCTCCTATGAATAAGTAATGTGAATTGTAGAAATCTTTGAT TTTTCTAATTTTTGTTTTATATTTGCCTTTCTTTTTTTTTTTTTT TTTTTTTTTTTCTTTTTCCTTATTTTTCTTTTTTTTAAAAAATAA ACATTTGTTTTTTTTTAATTAGTACTTATTTTTTTTGTTTAATTT TTATTTTTTTTTGTTGTTTCGTGCCTAGACCCGGCACATTTTTAT GACGTTACTTTTTTTTTTTAACCCGGGCCCCCCCCTTTTAGGAA

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C5-1	ß-TUBULIN (BT1)	AAGCGTCTGCTCTCTGACGCCGTGGTGCTCACTCTTTCCGCGCTGTCAGTGTTCCTGAGTTGACCCAACAGATGTTCGACCCCAAGAACATGATGGCTGCTTCGGACTTCCGTAACGGTCGCTACCTGACCTGCTCGGCCATTTTGTGAGTGAACTCGATTTTGCACATGAGAACTATTTACTGACTTTACATAGCCGTGGCCGTGTCGCTATGAAGGAGGTCGAGGACCAAATGCGCAACGTCCAGGCCAAGAACTCTTCTTACTTCGTTGAATGGATTCCCAACAATATCCAGACAGCCCTTTGTGCCATCCCTCCCCGAGGACTTACGATGTCTTCGACTTTCATCGGAAATTCCACCTCTATCCAGGAGCTCTTCAAGCGTGTTGGTGAGCAGTTCACTGCTATGTTCCGACGCAAGGCTTTCTTGCATTGGTATACTGGTGAGGGTATGGACGAGATGGAGTTCACTGAGGCTGAGTTCAACATGAACGATCTCATCA
C5-1	ITS (ITS1)	GGGGGTCGGGCTAACTCCAAACCCCTGTGACATACCAACTGTTGCCTCGGCGGATCAGCCCGCTCCCGGTAAAACGGGACGGCCCGCCAGAGGACCCCCAAACTCTGTTTCCATGTGTAACATCTGAGTAAAACCATAAATAAATCAAAACTTTCAACAACGGATCTCTTGGTTCTGGCATCGATGAAGAACGCAGCAAAATGCGATAAGTAATGTGAATTGCAGAATTCAGTGAATCATCGAATCTTTGAACGCACATTGCGCCCGCCAGTATTCTGGCGGGCATGCCTGTTCGAGCGTCATTTCAACCCTCAAGCCCAGCTTGGTGTTGGGACTCGCGAGTCAAATCGCGTTCCCCAAATTGATTGGCGGTCACGTCGAGCTTCCATAGCGTAGTAGTAAAACCCTCGTTACTGGTAATCGTCGCGGCCACGCCGTTAAACCCCAACTTCTGAATGTTGACCTCGGATCAGGTAGGAATACCCGCTGAACTTAAGAGTATCAATAAGCCAGAGGACACTCCAAACCCTGTGAACATACAACTGTTGCCTCGGCGGAT
C5-2	ß-TUBULIN (BT2)	GAGGCTCTCTGGCGAGCCGGCCTCGACAGCAATGGTGTCTACAACGGTACCTCCGAGCTCCAGCTCGAGCGCATGAGTGTCTACTTCAACGAGGTATGCATTAACAGTCAATGCCAATAATTCCCAAGCTCACACAACTAGGCCTCTGGCAACAAGTATGTTCCCCGAGCCGTCCTCGTCGATCTTGAGCCTGGTACCATGGACGCCGTCCGTGCTGGTCCCTTTGGTCAGCTCTTCCGTCCCGACAACTTCGTTTTCG

		GTCAGTCCGGTGCTGGAAACAACTGGGCCAAGGGTCACTACACTGAGGGTA
C5-2	ß-TUBULIN (BT1)	TTGTTTTCAACCAATCTGGTCTATTCCGCGGGTGAAAGTTCAAATGTTGCCTCGAGCGGATCAGCCCGCTCCCGGTAAAACGGGACGGCCCGCCAGAGGACCCCCAAACTCTGTTTCTATATGTAACTTCTGAGTAAAACCATAAATAAATCAAAACTTTCAACAACGGATCTCTTGGTTCTGGCATCGATGAAGAACGCAGCAAAATGCGATAAGTAATGTGAATTGCAGAATTCAGTGAATCATCGAATCTTTGAACGCACATTGCGCCCGCCAGTATTCTGGCGGGCATGCCTGTTCGAGCGTCATTTCAACCCTCAAGCCCAGCTTGGTGTTGGGACTCGCGAGTCAAATCGCGTTCCCCAAATTGATTGGCGGTCACGTCGAGCTTCCATAGCGTAGTAGTAAAACCCTCGTTACTGGTAATCGTCGCGGCCACGCCGTTAAACCCCAACTTCTGAATGTTGACCTCGGATCAGGTAGGAATACCCGCTGAACTTAAGCATATCAATAAGCGGAGGAAATTTTTTTCTATTTTAAATTTAATTTTTTTAAATACAATTGTTGTTCGGGGAAATAATTTCGGTATTTGGGTGGTCGCTTAGTACCTTAATTTTTTTTATTTGTAATTTTTAATAAATATAAATTAATAATATTTCAGTATCTTTGGTTTCGGTATCATTAAAAAGAAAAAGTCATAAATTAATGTGATTTGCATATTTTTGTGAATCTCCAATTATTGAAACATTGCGCCCTTTGGAGGGGTTTAAAATTTCTCTACCAACTGTTGTGTGGAATCGGGGTAATGTTCTTCATTATTGTGG
C5-2	TEF (EF1)	GACTCTGGCAGTCGACCACTGTGAGTACTACCCTCGATGATGAGCTTATCTGCCATCGAAACCCTCACCAAGACCTGGCGGGGTATTCCTCTTGAAACAAGATGCTGACATGGCTACACAGACCGGTCACTTGATCTACCAGTGCGGTGGTATCGACAAGCGAACCATCGAGAAGTTCGAGAAGGTTAGTCACTTTCCCTTCGATCGCGCGTCCTTTGTACATCGATTTCCCCTACGACTCGAAACGTGCCCGCTACCCCGCTCGAGACCAAAAATTTTGCGATATGACCGTAATTTTTTTGGTGGGGCATTTACCCCGCCACTCGAGCGATGGGCGCGTTTTTGCCCTTTCCTAGCCACAACTTCAATGAGCGCATCATCACGTGTCAAGCAGTCACTAACCATCTGACAATAGGAAGCCGCTGAGCTCGGTAAGGGTTCCTTCAAGTACGCCTGGGTTCTTGACAAGCTC

		AAGGCCGAGCGTGAGCGTGGTATCACCATCGATATTGCTCTCT GGAAGTTCGAGACTCCCCGCTACTATGTCACCGTCATTGGTAT GTTGTCGCTCATGCCTCACTCTATTTCCTAGTACTAACATGTCA CTCAGACGCTCCCGGTCACCGTGACTAAATC
C5-2	ITS (ITS1)	TTGTTTTCAACCAATCTGGTCTATTCCGCGGGTGAAAGTTCAA ATGTTGCCTCGAGCGGATCAGCCCGCTCCCGGTAAAACGGGAC GGCCCGCCAGAGGACCCCCAAACTCTGTTTCTATATGTAACTT CTGAGTAAAACCATAAATAAATCAAAACTTTCAACAACGGAT CTCTTGGTTCTGGCATCGATGAAGAACGCAGCAAAATGCGATA AGTAATGTGAATTGCAGAATTCAGTGAATCATCGAATCTTTGA ACGCACATTGCGCCCGCCAGTATTCTGGCGGGCATGCCTGTTC GAGCGTCATTTCAACCCTCAAGCCCAGCTTGGTGTTGGGACTC GCGAGTCAAATCGCGTTCCCCAAATTGATTGGCGGTCACGTCG AGCTTCCATAGCGTAGTAGTAAAACCCTCGTTACTGGTAATCG TCGCGGCCACGCCGTTAAACCCCAACTTCTGAATGTTGACCTC GGATCAGGTAGGAATACCCGCTGAACTTAAGCATATCAATAA GCGGAGGAAATTTTTTTCTATTTTAAATTTAATTTTTTTAAA
D100	ß-TUBULIN (BT2)	GCGTGCTTTTCTTGGCGGGCCGGTCTCGACAGCGATGGCCAGT ACGTTTTTCTCGACTACCCCTCCTGCCCTCCTCTCCCCTCCCCA TCGCACCGTCATCGCGTCGCGGTGGGGTAGAGGAAAAACAAA CAAGAGGTGATGCGATGGAGGAAGAAGAAAACCGACCACTGA CAATGCCCTTGCTACAGGTACAACGGCACCTCGGAGCTCCAGC TCGAGCGTATGAGCGTCTACTTTAACGAGGCCTCGGGCAACAA GTACGTCCCCCGTGCCGTCCTCGTCGATCTCGAGCCCGGCACC ATGGACGCTGTCCGCGCCGGTCCTTTCGGTCAGCTGTTCCGTC CCGACAACTTCGTTTTCGGCCAGTCGGGTGCTGGCAACAACTG GGCCAAGGGTCACTACACTGAGGGTA
D100	ITS (ITS1)	GCGGCTTGAAATATCAACTCCCAACCCATGTGACATATCTCTT TGTTGCCTCGGCGCAAGCTACCCGGGACCTCGCGCCCCGGGCG GCCCGCCGGCGGACAAACCAAACTCTGTTATCTTCGTTGATTA TCTGAGTGTCTTATTTAATAAGTCAAAACTTTCAACAACGGAT CTCTTGGTTCTGGCATCGATGAAGAACGCAGCGAAATGCGATA AGTAATGTGAATTGCAGAATTCAGTGAATCATCGAATCTTTGA

		ACGCACATTGCGCCCATTAGTATTCTAGTGGGCATGCCTGTTC GAGCGTCATTTCAACCCCTAAGCACAGCTTATTGTTGGGCGTC TACGTCTGTAGTGCCTCAAAGACATTGGCGGAGCGGCAGCAGT CCTCTGAGCGTAGTAATTCTTTATCTCGCTTCTGTTAGGCGCTG CCCCCCCGGCCGTAAAACCCCCAATTTTTTCTGGTTGACCTCG GATCAGGTAGGAATACCCGCTGAACTTAAGCATATCAATAGG CGGAGGAA
D11	TEF (EF1)	CAGTCGACCACCGTAAGTCAAACCCTCATCGCGATCTACTTAT CTCGGGTCGTGGAACCCCGCCTGGCATCTCGGGCGGGGTATTC ATCATTCACTTCATGCTGACAATCATCTACAGACCGGTCACTT GATCTACCAGTGCGGTGGTATCGACAAGCGAACCATCGAGAA GTTCGAGAAGGTTGGTGACATCTCCCCCGATCGCGCCTTGCTA TTCCACATCGAATCCCCTCCCTCGCGATACGCTCTGCGCCCGCT TCTCCCGAGTTCCAAAATTTTTGCGGTCCGACCGTAATTTTTTT GGTGGGGCATTTACCCCGCCACTCGGGCGACGTTGGACAAAG CCCTGATCCCTGCACACAAAA
D11	ITS (ITS1)	TGGGCTACGAACTAACACTCATCACCCTGTGAACATACCTAAA CGTTGCTTCGGCGGGAACAGACGGCCCCGTAACACGGGCCGC CCCCGCCAGAGGACCCCTAACTCTGTTTATATTATGTTTTTCT GAGTAAACAAGCAAATAAATTAAAACTTTCAACAACGGATCT CTTGGCTCTGGCATCGATGAAAAACGCAGCGAAATGCGATAA GTAATGTGAATTGCAAAATTCAGTGAATCATCAAATCTTTGAA CGCACATTGCGCCCGCCAGTATTCTGGCGGGCATGCCTGTTCG AGCGTCATTACAACCCTCAGGCCCCGGGCCTGGCGTTGGGGA TCGGCGGAAAGCCCCCTGTGGGCATACGCCGTCCCCTAAATAC AGTGGCGGTCCCGCCGCAGCTTCCATTGCGTAGTAGCTAACAC CTCGCAACTGGAGAGCGGCGCGGCCAAACCGTAAAACCCCCA ACTTCTGAATGTTGACCTCGAATCAGGTAGGAATACCCGCTGA ACTTAAGCATATCAATAAGCGGAGGAA
D113	ITS (ITS1)	GGGGGGTTCAAATTGAGGCGGGCTGGATCTCTCGGGGTTACA GCCTTGCTGAATTATTCACCCTTGTCTTTTGCGTACTTCTTGTTT CCTTGGTGGGTTCGCCCACCACTAGGACAAACATAAACCTTTT GTAATTGCAATCAGCGTCAGTAACAAATTAATAATTACAACTT

		TCAACAACGGATCTCTTGGTTCTGGCATCGATGAAGAACGCAG CGAAATGCGATAAGTAGTGTGAATTGCAGAATTCAGTGAATC ATCGAATCTTTGAACGCACATTGCGCCCTTTGGTATTCCAAAG GGCATGCCTGTTCGAGCGTCATTTGTACCCTCAAGCTTTGCTTG GTGTTGGGCGTCTTGTCTCTAGCTTTGCTGGAGACTCGCCTTAA AGTAATTGGCAGCCGGCCTACTGGTTTCGGAGCGCAGCACAA GTCGCACTCTCTATCAGCAAAGGTCTAGCATCCATTAAGCCTT TTTTCAACTTTTGACCTCGGATCAGGTAGGGATACCCGCTGAA CTTAAGCATATCAATAGGCCGGAGGAGGGGGGTGGAAACTC GTGGGGTTACAGCCTTGCTGAATTATTACCCGGGCCCTTGGGG ATTTGGTTTTCCGGGGGGGGTTCCCCCTAGACAAAATAAACCT TTGTAATTGCATTCACGGCCGGACCAATTAAAAATAAACTTTA CAACGGACTCTTGGTTCGGGGTGATGAAAAAACACGAAAGGG ATAAATGTGGGAATTGGGGAAATTCGCTGAATATGGAAGCTTT GAACATGGCTTTGGTTGTCTAGGGCTGCGGTGAAGGCCATTGG TGCCTCAGCTGGCTGGGTTGGGGGCTTGACTCTGCTTGCTGGG AAATGCTTAAGTATTGGAGCCACGGTTTCGGGAGCGCAAGTG ACTCATAGCAAGTGAACATTAGCGTTGCAATGGACCGATGTGA GATCATAAGCTCTCGAGGAATT
D117	ß-TUBULIN (BT2)	GCCGGTCTCGACAGCATGGTGTTTACAACGGTACCTCCGAGCT CCAGCTCGAGCGTATGAGCGTCTACTTCAACGAGGTATGTTTC ATCACTCCTGCCACAAAAACACAACAAGCTCACGCGCGCCTA GGCTTCCGGTAACAAGTATGTTCCCCGTGCCGTCCTCGTCGAT CTCGAGCCCGGTACCATGGACGCCGTCCGTGCCGGTCCTTTCG GACAGCTTTTCCGTCCCGACAACTTCGTTTTCGGTCAATCCGGT GCCGGAAACAACTGGGCCAAGGGTCACTACACTGAGGGTAGG TA
D119	ITS (ITS1)	TTGCTTCGTCACTCTACGTCGCTCCCAACCATGAGAACATATCT CTTTGTTGCCTCGGCGCAAGATACCCGGGACCTCGCGCCCCGG GCGCCCGCCGCGGACAAACCAAACTCTGTTATCTTCGTTGATT ATCTGAGTGCCTTATTTAATAAGTCAAAACTTTCAACAACGGA TCTCTTGGTTCTGGCATCGATGAAGAACGCAGCGAAATGCGAA AAGTAATGTGAATTGCAGAATTCAGGGAATCATCGAATCTTTG

		AAGGCACATTGCGCCCATTAGTATTCTAGTGGGCATGCCTGTT CGAGCGTCATTTCAACCCCTAAGCCAGCTTATGGTGGGGCGTC TACGCCTGTGGTGCCTCAAAGACATTGCGGAACGGCGCGGTCT CTGAGCGAGTAATTCTTTACTCGTTCTGTAGGCGCGCCCCCCC GCCGAAAACCCCATTTTTTCTGGTGACTCGATCAGTAGATACC GCTGAATTAAGATATCATAGCGGAGAACCTCCCGGCGTTAATG TCTTTTTGTGCGCGAGAAACCAAGGGGCGTGGGGCGCGGGGG AGACCGGTTATGGTGTTTCGTGCCCTGATGGTATAGGAGTTGC TGGGACTGGGTTCTTTTTGGTGGTGGGAGATGTGTATTAGCGG GGGGAGGTG
D124	ITS (ITS1)	TGGGCCTAACAAATACGAGGCCGTTCGCGGCTGGACTATTTAT TACCCTTGTCTTTTGCGCACTTGTTGTTTCCTGGGCGGGTTCGC TCGCCACCAGGACCACCATATAAACCTTTTTTATGCAGTTGCA ATCAGCGTCAGTATAACAAATGTAAATCATTTACAACTTTCAA CAACGGATCTCTTGGTTCTGGCATCGATGAAGAACGCAGCGAA ATGCGATACGTAGTGTGAATTGCAGAATTCAGTGAATCATCGA ATCTTTGAACGCACATTGCGCCCTTTGGTATTCCAAAGGGCAT GCCTGTTCGAGCGTCATTTGTACCCTCAAGCTTTGCTTGGTGTT GGGCGTTTTTGTCCCCCTAACAAGGGACTCGCCTTAAAAGGAT TGGCAGCCGGCCTACTGGTTTCGCAGCGCAGCACATTTTTGCG CTTGCAATCAGCAAAAGAGGACGGCAATCCATCAAGACTCCTT CTCACGTTTGACCTCGGATCAGGTAGGGATACCCGCTGAACTT AAGCATATCAATAAGCGGAGGAA
D124	GpDef	AATCCATTGGTCCAGTGCGTATCAAAGCTAACCGTAGCTCGCA GCATCGAGCACAACGACGTCGAGATTGTCGCCGTCAACGACC CCTTCATCGAGCCCCACTACGCTGTAAGCACATCCTACCGTCA GAGCATCCATGGGCGGAGCAGCACACACTAACATCGACACAG GCGTACATGCTCAAGTATGACAGCACACACGGCCAGTTCAAG GGCGACATCAAGGTTGACGGCAACAACCTGACCGTCAACGGC AAGACCGTCCGCTTCCACATGGAGAAGGACCCCGCCAACATC CCATGGAGCGAGACCGGCGCCTACTACGTCGTCGAGTCCACCG
D125	ß-TUBUL	TATTTCTCTCTGGCGAGCCGGCCTCGACAGCAATGGTGTCTAC AACGGTACCTCCGAGCTCCAGCTCGAGCGCATGAGTGTCTACT

	IN (BT2)	TCAACGAGGTATGCATTAACAGTCAATGCCAATAATTCCCAAG CTCACACAACTAGGCCTCTGGCAACAAGTATGTTCCCCGAGCC GTCCTCGTCGATCTTGAGCCTGGTACCATGGACGCCGTCCGTG CTGGTCCCTTTGGTCAGCTCTTCCGTCCCGACAACTTCGTTTTC GGTCAGTCCGGTGCTGGAAACAACTGGGCCAAGGGTCACAAC ACTGAGGGTA
D125	ß-TUBULIN (BT1)	AGGGGGCTGCTCTCTGAAGCCGTGGTGCTCACTCTTTCCGCGC TGTCAGTGTTCCTGAGTTGACCCAACAGATGTTCGACCCCAAG AACATGATGGCTGCTTCGGACTTCCGTAACGGTCGCTACCTGA CCTGCTCGGCCATTTTGTGAGTGAACTCGATTTTGCACATGAG AACTATTTACTGACTTTACATAGCCGTGGCCGTGTCGCTATGA AGGAGGTCGAGGACCAAATGCGCAACGTCCAGGCCAAGAACT CTTCTTACTTCGTTGAATGGATTCCCAACAATATCCAGACAGC CCTTTGTGCCATCCCTCCCCGAGGACTTACGATGTCTTCGACTT TCATCGGAAATTCCACCTCTATCCAGGAGCTCTTCAAGCGTGT TGGTGAGCAGTTCACTGCTATGTTCCGACGCAAGGCTTTCTTG CATTGGTATACTGGTGAGGGTATGGACGAGATGGAGTTCACTG AGGCTGAGTTCAACATGAACGATCTCATCA
D125	TEF (EF1)	GACTCTGGCAGTCGACCACTGTGAGTACTACCCTCGATGATGA GCTTATCTGCCATCGAAACCCTCACCAAGACCTGGCGGGGTAT TCCTCTTGAAACAAGATGCTGACATGGCTACACAGACCGGTCA CTTGATCTACCAGTGCGGTGGTATCGACAAGCGAACCATCGAG AAGTTCGAGAAGGTTAGTCACTTTCCCTTCGATCGCGCGTCCT TTGTACATCGATTTCCCCTACGACTCGAAACGTGCCCGCTACC CCGCTCGAGACCAAAAATTTTGCGATATGACCGTAATTTTTTT GGTGGGGCATTTACCCCGCCACTCGAGCGATGGGCGCGTTTTT GCCCTTTCCTAGCCACAACTTCAATGAGCGCATCATCACGTGT CAAGCAGTCACTAACCATCTGACAATAGGAAGCCGCTGAGCT CGGTAAGGGTTCCTTCAAGTACGCCTGGGTTCTTGACAAGCTC AAGGCCGAGCGTGAGCGTGGTATCACCATCGATATTGCTCTCT GGAAGTTCGAGACTCCCCGCTACTATGTCACCGTCATTGGTAT GTTGTCGCTCATGCCTCACTCTATTTCCTAGTACTAACATGTCA CTCAGACGCTCCCGGTCACCGTGACTACATCAA

D125	ITS (ITS1)	GTGGTACGCAAATATCTACGGTGTCCTGTTGCTGTACCATTGTCCGCCTCGGCGGATCTTCCCGCTCCCGGTTTGACCGCTTTTTCCGTCCGGGGACACCCAAACTCTGTTTCTGATGTAACTTCTGACTTTTTTTATGCTAAATCAAAACTTTCCACAACGGATCTCTTGGTTCTGGAATCTATGACAAACGATCTCTTGGCGAGGGTAATGTGAATTGCAGAATTCAATGAATCATCTAATGTGTGAACGCAAATTGCGCCCGCCAGTATTCTGGCGAACGTGCCTGTTCGAGCGTCATTTCAACCCTCAAGCCCATGTTGGAGTTGGGACTGTACCAGTCAGCTTTGCTTCCCCGTTGTGATTGTTTTTCACTCTCAGCTTGTTGGGGGAAGAATCAAAACCCTCGTTACGGGTAATCATCTCGGGCTCTCCGGAAAACCCCAACTTCTGAATGCTTACCTCCGATCGGGTGGGATTACCCGCTGAATTTATTTTTATTAATAAGTCCAGGAATTGACCTCGGATCAGGTAGGGATACCCGCTGAACTTAAGCATATCAATAAGCGGAGGAAA
D126	ITS (ITS1)	TCGGGCCTCTCAAAATATGAGGGTGTGGTTTGCTGGCAACAGCGTCCGCCCCAAGTATTTTTCACCCATGTCTTTTGCGCACTTTTTGTTTCCTGGGCGAGTTCGCTCGCCACCAGGACCCAACCATAAACCTTTTTTTATGCAGTTGCAATCAGCGTCAGTATAATAATTCAATTTATTAAAACTTTCAACAACGGATCTCTTGGTTCTGGCATCGATGAAGAACGCAGCGAAATGCGATACGTAGTGTGAATTGCAGAATTCAGTGAATCATCGAATCTTTGAACGCACATTGCGCCCTTTGGTATTCCAAAGGGCATGCCTGTTCGAGCGTCATTTGTACCCTCAAGCTTTGCTTGGTGTTGGGCGTCTTTTTGTCTCTCCCCTTGTTGGGGGAGACTCGCCTTAAAACGATTGGCAGCCGACCTACTGGTTTTCGGAGCGCAGCACAAATTTGCGCCTTCCAATCCACGGGGCGGCATCCAGCAAGCCTTTGTTTTCTATAACAAATCCACATTTTGACCTCGGATCAGGTAGGGATACCCGCTGAACTTAAGCATATCAATAAGCGGAGGAA
D127	ß-TUBULIN (BT2)	GGGGCATTCCTCTGGGCGAGCCGGCCTCGACAGCAATGGTGTCTACAACGGTACCTCCGAGCTCCAGCTCGAGCGCATGAGTGTCTACTTCAACGAGGTATGCCTTAACAGTCAATGCCAACGATCCACAAGCTCACACAACTAGGCCTCTGGCAACAAGTATGTTCCCCGAGCCGTCCTCGTCGATCTTGAGCCTGGTACCATGGACGCTGTCC

		GTGCTGGTCCCTTCGGTCAGCTCTTCCGTCCCGACAACTTCGTTTTCGGTCAGTCCGGTGCTGGAAACAACTGGGCCAAGGGTAACTACACTGAGGGTA
D127	TEF (EF1)	ACTCTGGCAGTCGACCACTGTGAGTACTACCCTGGACGATGAGCTTATCTGCCATCGTGATCCTGACCAAGATCTGGCGGGGTACATCTTGGAAGACAATATGCTGACATCGCTTCACAGACCGGTCACTTGATCTACCAGTGCGGTGGTATCGACAAGCGAACCATCGAGAAGTTCGAGAAGGTTAGTCACTTTCCCTTCGATCGCGCGTCCTCTGCCCACCGATTTCACTTGCGATTCGAAACGTGCCTGCTACCCCGCTCGAGACCAAAAATTTTGCGATATGACCGTAATTTTTTTGGTGGGGCATTCACCCCGCCACTCGAGCGATGGGCGCGTTTTTGCCCTCTCCTGTCCACAACCTCAATGAGCGCATTGTCACGTGTCAAGCAGCGACTAACCATTCGACAATAGGAAGCCGCTGAGCTCGGTAAGGGTTCCTTCAAGTACGCCTGGGTTCTTGACAAGCTCAAGGCCGAGCGTGAGCGTGGTATCACCATCGATATTGCTCTCTGGAAGTTCGAGACTCCTCGCTACTATGTCACCGTCATTGGTATGTTGTCGCTCATACCTCATCCTACTTCCTCATACTAACACATCATTCAGACGCTCCCGGTCACCGTGATTTCATCAAGAACATGATCACTGGTACTTCCC
D127	ITS (ITS1)	GGGGAAATGAACTAACTCCAACCCCTGTGACATACCTATACGTTGCCTCGGCGGATCAGCCCGCGCCCTGTAAAACGGGACGGCCCGCCCGAGGACCCTAAACTCTGTTTTTAGTGGAACTTCTGAGTAAAACAAACAAATAAATCAAAACTTTCAACAACGGATCTCTTGGTTCTGGCATCGATGAAGAACGCAGCAAAATGCGATAAGTAATGTGAATTGCAGAATTCAGTGAATCATCGAATCTTTGAACGCACATTGCGCCCGCCAGTATTCTGGCGGGCATGCCTGTTCGAGCGTCATTTCAACCCTCAAGCTCAGCTTGGTGTTGGGACTCGCGGTAACCCGCGTTCCCCAAATCGATTGGCGGTCACGTCGAGCTTCCATAGCGTAATAATCATACACCTCGTTACTGGTAATCGTCGCGGCCACGCCGTAAAACCCCAACTTCTGAATGTTGACCTCGGATCAGGTAGGAATACCCGCTGAACTTAAGCATATCAATAACCGGAAGAAATC

D128	ITS (ITS1)	GTGAACGGACTAGCTCTGCACCCTTTGTGACATACCTATAACT GTTGCTTCGGCGGGTAGGGTCCCCGTGACCCTCCCGGCCCCCC GCCCCCGGGCGGGTCGGCGCCCGCCGGAGGATAACCAAACTC TGATTTAACGACGTTTCTTCTGAGTGGTACAAGCAAATAATCA AAACTTTTAACAACGGATCTCTTGGTTCTGGCATCGATGAAGA ACGCAGCGAAATGCGATAAGTAATGTGAATTGCAGAATTCAG TGAATCATCGAATCTTTGAACGCACATTGCGCCCGCCAGCATT CTGGCGGGCATGCCTGTTCGAGCGTCATTTCAACCCTCAAGCT CTGCTTGGTGTTGGGGCCCTACAGCAGATGTAGGCCCTCAAAG GTAGTGGCGGACCCTCCCGGAGCCTCCTTTGCGTAGTAACTTT ACGTCTCGCACTGGGATCCGGAGGGACTCTTGCCGTAAAACCC CCCAATTTTCCAAAGGTTGACCTCGGATCAGGTAGGAATACCC GCTGAACTTAAGCATATCAATAAGGCGGAGGAAATTTCCCCCC CCCCAACCCTTGGAGAAAAAACCTATAATTTTTTGTTCGGGGG GGAGGGGGCCGGGGAATCCCGGCCCCCCCCCGGGGGGGGT GGGCCCCCCCCGAGAGAAAACAAAAAGTTTATTTAAAACTTTT TTTTCCGGGGGGGGAGACAAAAAAAAAAAAATTTTTTAAAAC GAATTTGGGTTCTGGGCTTCATAAAAAAAACCAAAGGCCGAG GAAAAAGCGAGAATGGCAAAAATCTCGAAAAACAAACAATTT AAGAAGCGCCCCCGTGCTGGAAGGTATCTACCAATATCTGCTC GAGTTTGGTGGGAGGGACAACCCCACAATAGGACCCTAATCG AGGCGACGGCCCCGAACCCCCTTTCGAGAGACTAAGAAGCGA CGCTGTAAGACAGCACGCACGACACCATATGGCCCAAGGGAT AGAGACCTCCCTCGAATAGGTAGGATATCGCTGAACTTAGCAA TATCAGTTATCGGCGAGAAGAAAAA
D130	ITS (ITS1)	GGGGCTCAACGTTGTGGGCTTTGCCTGCTATCTCTTACCCATGT CTTTTGAGTACCTTCGTTTCCTCGGCGGGTCCGCCCGCCGATCG GACAACCATAAACCATTTGCAGTTGCAATCAGCGTCTGAAAAA CTTTAATAGTTACAACTTTCAACAACGGATCTCTTGGTTCTGGC ATCGATGAAGAACGCAGCGAAATGCGATAAGTAGTGTGAATT GCAGAATTCAGTGAATCATCGAATCTTTGAACGCACATTGCGC CCCTTGGTATTCCATGGGGCATGCCTGTTCGAGCGTCATTTGTA CCTTCAAGCTCTGCTTGGTGTTGGGTGTTTGTCTCGCCTCTGCG CGTAGACTCGCCTCAAAACGATTGGCAGCCGGCGTATTGATTT

		CGGAGCGCAGTACATCTCGCGCTTTGCACTCACAACGACGACG TCCAAAAGCACATTTTTACACTCTTGACCTCGGATCAGGTAGG GATACCCGCTGAACTTAAGCATATCAATAAGACGTTAGTGGGG CTTTGCCTGCTATCTCTTACCATGTCTTTTGGAGTACTTTGTTTT CCTCGGCGGGTCCCCGCCATGGGACAACCATTAAACCATTTGC AGTTGCAATCAGCGTCTGAAAAACTTTAAAAGTTACAACTTTC ACAACGGATCTCTTGGTTTCTGGCATCGATGCAAAAAGCAGGA AAAGGGATAAGTTAGTGTGAATTGGCAGAATTCAGTGAATCA TTCGAATCTTTTGACGCATGCTGGTACTTCATGGGGGGCATGC TGTTCCAGCTTTTGTTCTTCAGCCTGCCTGTGTGGGTGTTTGTC TCGGCTCTGCGCTAGACGCTAAACGATGCAGCAGGTATGATTC GAAGGCATAATCTGGCTTGCTCAACGACACTCAAGCCATTTAC CCTGGACTCGATCGGTAGATACCCTGACTTATTATCGTAGAAG AATAGA
D131	ß-TUBULIN (BT2)	GAGGGTGTTCGGCCAGTCTGGTGCTGGTAACAACTGGGCCAA GGGTCACTACACTGAGGGTA
D132	ß-TUBULIN (BT2)	CGGCGAGCATGGCCTCGACGGCTCCGGTGTCTACAACGGCACC TCGGATCTCCAGCTCGAGCGCATGAACGTCTACTTCAACGAGG TACTAGAAATGACACTCTTCCCATAGACGGACTGCGAGTGCTG ACCTTCCACAGGCCTCCGGCAACAAGTTCGTTCCCCGTGCCGT CCTCGTCGATTTGGAGCCCGGCACAATGGACGCTGTCCGCGCT GGTCCCTTCGGTCAGCTCTTCCGTCCCGACAACTTCGTCTTCGG CCAGTCTGGTGCTGGTAACAACTGGGCCAAGGGTCACTACACT GAGGGTA
D134	ITS (ITS1)	CGGCAACTTGAGTTGTAGCTTTGCCTGCTATCTCTTACCCATGT CTTTTGAGTACCTTACGTTTCCTCGGTGGGTTCGCCCACCGATT GGACAAATTTAAACCCTTTGCAGTTGAAATCAGCGTCTGAAAA AACTTAATAGTTACAACTTTCAACAACGGATCTCTTGGTTCTG GCATCGATGAAGAACGCAGCGAAATGCGATAAGTAGTGTGAA TTGCAGAATTCAGTGAATCATCGAATCTTTGAACGCACATTGC GCCCCTTGGTATTCCATGGGGCATGCCTGTTCGAGCGTCATTT

		GTACCTTCAAGCTCTGCTTGGTGTTGGGTGTTTGTCTCCTGTAG ACTCGCCTTAAAACAATTGGCAGCCGGCGTATTGATTTCGGAG CGCAGTACATCTCGCGCTTTGCACTCATAACGACGACATCCAA AAGTACATTTTTACACTCTTGACCTCGGATCAGGTAGGGATAC CCGCTGAACTTAAGCATATCAATAATACAGATGAGACTTTGCC TGCTATCTCTTACCATGTCTTTTGAGTACTTACGTTTTCTGGTG GGTTCGCCACGATTGGGACAAATTTAAACCTTTGCGTTGAAAT CGGTCTGAAAAACTTAATAGTTACAACTTTCACAACGGATCTC TTGGTTCTGGCATCATGAAGAACGCAGCAAAATGCATAAGTA GTGTGAATTGCAGAAATTCAGTGAATCATCGAATCTTTGAACG CATTGTCTGCTATTCATGGGGGCATGCTGCTTCAGTATTTGTAC TTCAGCTCTGCTTGTGTTGGGTGTTTGTCTCTGTAGACTCGCTT AAAACAATTGCAGCGCTATTGATTTCGTAGGATCTTCGCTTTG CCTCATACGACGACTCAAGTAATTTTACCTCTGACTCGATCAG TAGATCAGCTGACTTTAGTTGCGTGAGGAAGCA
D135	ITS (ITS1)	GAGGCTGTTGAATAGGGGTGCCAAGGCGCATTCAGACCGGCT GAGATTATTTTTCTTCACCCTTGTCTTTTGCGCACTTGTTGTTTC CTGGGCGGGTTCGCTCGCCACCAGGACCACACCATAAACCTTT TTGTTAATGCAATCAGCGTCAGTAAAAAGTAATAATTATTTTA CAACTTTCAACAACGGATCTCTTGGTTCTGGCATCGATGAAGA ACGCAGCGAAATGCGATACGTAGTGTGAATTGCAGAATTCAG TGAATCATCGAATCTTTGAACGCACATTGCGCCCTTTGGTATTC CAAAGGGCATGCCTGTTCGAGCGTCATTTGTACCCTCAAGCTT TGCTTGGTGTTGGGCGTTGTTTGTCTTTGGCCTTGCCCAAAGAC TCCCCTTAAAACAATTGGGAACCGGGCTACTGGGTTCGCAGCG CAGCACATGTTTTGCCTTGCGATCCTGAAAAAAGTTGGACAAC CCATGAGAACCATTTTTCCTTTTGAACGTTGGATTGGGAAGGA GAAGCCTCCGACCGAAAAATAATAAAAAAATGGAAAAAAAG AAGGGCCCTTCAACCGGCGGGAATTAATTTTTTTTCCCCTGTC TTTTTGCACACTGTTTGTTTTCTGGGGGGGGGTTCTCTCCCCCC CGACCCCCCCTTAACCCTTTTGGTAAAGGAAATCGGGTCGGTT AAAAGCTAACAAATTATTTTAAAAACATTTCCACGGAACCCTG TGTTCCGGCATTCAGGGATAAGGCAGCAATAGGCATACCGCA AGGGGGAATTGAGGAAGTAAATTGAAAAACCAAGTTTTCACC

		ACGTCCCTTGGGCGGCCTAGGGGCATTCCGGGCAAGCGTAAC AGGGACCTTAGCACTCATGTGGTTGGGGGGTTGGTGTGTTGTT TTGGCTCTTTGCCCGGGCCCATGTAACTAAAATGAGAAGGGGG CCGGACGATTGTGTCGCCGACGCACCAATTTTTGTGCCCGTTG GAATCCGCAAAAAAAAGGGGTGGGGCTCCCCCCTAGCACAGA CACTGTATAACTGCGTAACACGCGGCACAAGTGCCGGGGGGT AAGACCCCTGGACGTTTATAAGACTCAAATACACTTTATAAAC GGAGAGAGGAAGAAAGATA
D135	GpDef	CCGCCGACGCCCCCATGTTCG
D137	ITS (ITS1)	GGGGGTTCGGAGTTAACTCCCAACCCCTGTGACATACCTATAC GTTGCCTCGGCGGATCAGCCCGCGCCCTGTAAAACGGGACGG CCCGCCCGAGGACCCTAAACTCTGTTTTAGTGGAACTTCTGA GTAAAACAAACAAATAAATCAAAACTTTCAACAACGGATCTC TTGGTTCTGGCATCGATGAAGAACGCAGCAAAATGCGATAAG TAATGTGAATTGCAGAATTCAGTGAATCATCGAATCTTTGAAC GCACATTGCGCCCGCCAGTATTCTGGCGGGCATGCCTGTTCGA GCGTCATTTCAACCCTCAAGCTCAGCTTGGTGTTGGGACTCGC GGTAACCCGCGTTCCCCAAATCGATTGGCGGTCACGTCGAGCT TCCATAGCGTAGTAATCATACACCTCGTTACTGGTAATCGTCG CGGCCACGCCGTAAAACCCCAACTTCTGAATGTTGACCTCGGA TCAGGTAGGAATACCCGCTGAACTTAAGCATATCAATAAACG GAGGAAA
D137	TEF (EF1)	TATCTCGGGCGGGGTATTCATCAGTCACTTCATGCTGACAATC ATCTACGGACCGGTCACTTGATCTACCAGTGCGGTGGTATCGA CAAGCGAACCATCGAGAAGTTCGAGAAGGTTGGTGACATCTC TCCCGATCGCGCCTTGCTATTCCACATCGAATTCCCCGTCGAAT TCCCTCCTCCGCGACACGCTCTGCGCCCGCTTCTCCCGAGTCCC AAAATTTTTGCGGTTCGACCGTAATTTTTTTTTGGTGGGGCAT CTACCCCGCCACTCGGGCGACGTTGGACAAAGCCCTGATCCCT GCACACAAAAACACCAAACCCTCTGGGCGCGCATCACGTGGT TCACAACAGACACTGACGGGTTCAACAATAGGAAGCCGCTGA GCTCGGTAAGGGTTCCTTCAAGTACGCCGGGGTCCTTGACAAG CTCAAGGCCGAGCGTGAGCGTGGTATCACCATCGATATTGCTC

		TCTGGAAGTTCGAGACTCCCCGCTACTATGTCACCGTCATTGG TATGTCGCCGTCATGTCTCTCTCTCTCACTCACGTCTCATCACT AACAATCAACAGACGCCCCCGGCCACCGTG
D143	ITS (ITS1)	GGGGGCTCGGGCTCACTCCAACCCCTGTGACATACCTATACGT TGCCTCGGCGGATCAGCCCGCGCCCCGTAAAACGGGACGGCC CGCCCGAGGACCCCTAAACTCTGTTTTTAGTGGAACTTCTGAG TAAAACAAACAAATAAATCAAAACTTTCAACAACGGATCTCTT GGTTCTGGCATCGATGAAGAACGCAGCAAAATGCGATAAGTA ATGTGAATTGCAGAATTCAGTGAATCATCGAATCTTTGAACGC ACATTGCGCCCGCCAGTATTCTGGCGGGCATGCCTGTTCGAGC GTCATTTCAACCCTCAAGCTCAGCTTGGTGTTGGGACTCGCGG TAACCCGCGTTCCCCAAATCGATTGGCGGTCACGTCGAGCTTC CATAGCGTAGTAATCATACACCTCGTTACTGGTAATCGTCGCG GCCACGCCGTAAAACCCCAACTTCTGAATGTTGACCTCGGATC AGGTAGGAATACCCGCTGAACTTAAGCATATCAATAGGCGGA GGAAG
D146	ß-TUBULIN (BT1)	AGGGGGCCCGCCTCTCTGAAGCCGTGGTGCTCACTCTTTCCGC GCTGTCAGTGTTCCTGAGTTGACCCAACAGATGTTCGACCCCA AGAACATGATGGCTGCTTCGGACTTCCGTAACGGTCGCTACCT GACCTGCTCGGCCATTTTGTGAGTGAACTCGATTTTGCACATG AGAACTATTTACTGACTTTACATAGCCGTGGCCGTGTCGCTAT GAAGGAGGTCGAGGACCAAATGCGCAACGTCCAGGCCAAGAA CTCTTCTTACTTCGTTGAATGGATTCCCAACAATATCCAGACA GCCCTTTGTGCCATCCCTCCCCGAGGACTTACGATGTCTTCGAC TTTCATCGGAAATTCCACCTCTATCCAGGAGCTCTTCAAGCGT GTTGGTGAGCAGTTCACTGCTATGTTCCGACGCAAGGCTTTCT TGCATTGGTATACTGGTGAGGGTATGGACGAGATGGAGTTCAC TGAGGCTGAGTTCAACATGAACGATCTCATCA
D146	ITS (ITS1)	GGGGCTCGGGCTTCACTCCAAACCCCTGTGACATACCAATTGT TGCCTCGGCGGATCAGCCCGCTCCCGGTAAAACGGGACGGCC CGCCAGAGGACCCCCAAACTCTGTTTCTATATGTAACTTCTGA GTAAAACCATAAATAAATCAAAACTTTCAACAACGGATCTCTT GGTTCTGGCATCGATGAAGAACGCAGCAAAATGCGATAAGTA

		ATGTGAATTGCAGAATTCAGTGAATCATCGAATCTTTGAACGC ACATTGCGCCCGCCAGTATTCTGGCGGGCATGCCTGTTCGAGC GTCATTTCAACCCTCAAGCCCAGCTTGGTGTTGGGACTCGCGA GTCAAATCGCGTTCCCCAAATTGATTGGCGGTCACGTCGAGCT TCCATAGCGTAGTAGTAAAACCCTCGTTACTGGTAATCGTCGC GGCCACGCCGTTAAACCCCAACTTCTGAATGTTGACCTCGGAT CAGGTAGGAATACCCGCTGAACTTAAGCATATCAATAAGCGG AGGAA
D148	ß-TUBULIN (BT2)	GAGTCTCTCTGGCGAGCCGGTCTCGACAGCAATGGTGTTTACA ACGGTACCTCCGAGCTCCAGCTCGAGCGTATGAGCGTCTACTT CAACGAGGTTTGTTTCATCACTCCTGCCACGAAAACACAACAA GCTCACGCGCGCCTAGGCTTCCGGTAACAAGTATGTTCCCCGT GCCGTCCTCGTCGATCTCGAGCCCGGTACCATGGACGCCGTCC GTGCCGGTCCTTTCGGACAGCTTTTCCGTCCCGACAACTTCGTT TTCGGTCAATCCGGTGCCGGAAACAACTGGGCCAAGGGTCAC AACACTGAGGGTA
D152	ß-TUBULIN (BT2)	AGTCTCTCTGGCGAGCCGGCCTCGACAGCAATGGTGTCTACAA CGGTACCTCCGAGCTTCAGCTCGAGCGCATGAGTGTTTACTTT AACGAGGTATGTATTAGCAGTCAATGTCAAGAGTTCCCAAGCT TACACATCTAGGCCTCTGGCAACAAGTATGTTCCCCGAGCCGT CCTCGTCGATCTCGAGCCTGGTACCATGGACGCCGTCCGTGCT GGTCCCTTCGGCCAGCTCTTCCGTCCTGACAACTTCGTTTTCGG TCAGTCCGGTGCTGGAAACAACTGGGCCAAGGGTCACTACACT GAGGGTA
D152	TEF (EF1)	TACTCTGGCAGTCGACCACTGTGAGTACTACCCTTGACGATGA GCTTATCGGCCATCGTAATCCCGACCAAGACCTGGCGGGGTAT TTTCAAAAGAAAACATGCTGACATCGCTTCACAGACCGGTCAC TTGATCTACCAGTGCGGTGGTATCGACAAGCGAACCATCGAGA AGTTCGAGAAGGTTAGTCACAATCCCTTCGATCGCGCTTCCTT TGTCCACCGATTTCTCCCTACGACTCGAAACGTGCCCGCTACC CCGCTCGAGTCCAAAAATTTTGCGATATGACCGTAATTTTTTTT GGGTGGGGTATCTACCCCGCCACTCGAGCGGCGCGTTTTTGCC CTCTCCCATTCCACAACCTCATTGAGCGCATCGTCACGTGTCA

		AGCAGTCACTAACCATTCGACAATAGGAAGCCGCTGAGCTCG GTAAGGGTTCCTTCAAGTACGCCTGGGTTCTTGACAAGCTCAA GGCCGAGCGTGAGCGTGGTATCACCATCGATATTGCTCTCTGG AAGTTCGAGACTCCTCGCTACTATGTCACCGTCATTGGTATGTT GTCGCTCATGCTTCATTCTACATCTCTTCTTACTAACATGTCAC TCAGACGCTCCCGGTCACCGTGATTTCATCAAGAACATGATCA CTA
D152	ITS (ITS1)	GGGCGTTCGGAGATACTCCCAAACCCCTGTGACATACCAATTG TTGCCTCGGCGGATCAGCCCGCTCCCGGTAAAACGGGACGGCC CGCCAGAGGACCCCTAAACTCTGTTTCTATATGTAACTTCTGA GTAAAACCATAAATAAATCAAAACTTTCAACAACGGATCTCTT GGTTCTGGCATCGATGAAGAACGCAGCAAAATGCGATAAGTA ATGTGAATTGCAGAATTCAGTGAATCATCGAATCTTTGAACGC ACATTGCGCCCGCCAGTATTCTGGCGGGCATGCCTGTTCGAGC GTCATTTCAACCCTCAAGCCCCCGGGTTTGGTGTTGGGGATCG GCGAGCCTCACGGCAAGCCGGCCCCGAAATACAGTGGCGGTC TCGCTGCAGCTTCCATTGCGTAGTAGTAAAACCCTCGCAACTG GTACGCGGCGCGGCCAAGCCGTTAAACCCCCAACTTCTGAATG TTGACCTCGGATCAGGTAGGAATACCCGCTGAACTTAAGCATA TCAATAAGCCGGAGGAAGTT
D164	ß-TUBULIN (BT2)	GAGTACTTTCTCTGGCGAGCCGGCCTCGACAGCATGGTGTCTA CAACGGTACCTCCGAGCTCCAGCTCGAGCGCATGAGTGTCTAC TTCAACGAGGTATGCATTAACAGTCAATGCCAATAATTCCCAA GCTCACACAACTAGGCCTCTGGCAACAAGTATGTTCCCCGAGC CGTCCTCGTCGATCTTGAGCCTGGTACCATGGACGCCGTCCGT GCTGGTCCCTTTGGTCAGCTCTTCCGTCCCGACAACTTCGTTTT CGGTCAGTCCGGTGCTGGAAACAACTGGGCCAAGGGTCACTA AACTGAGGGTAA
D164	TEF (EF1)	AGTCGACCACTGTGAGTACTACCCTCGATGATGAGCTTATCTG CCATCGAAACCCTCACCAAGACCTGGCGGGGTATTCCTCTTGA AACAAGATGCTGACATGGCTACACAGACCGGTCACTTGATCTA CCAGTGCGGTGGTATCGACAAGCGAACCATCGAGAAGTTCGA GAAGGTTAGTCACTTTCCCTTCGATCGCGCGTCCTTTGTACATC

		GATTTCCCCTACGACTCGAAACGTGCCCGCTACCCCGCTCGAG ACCAAAAATTTTGCGATATGACCGTAATTTTTTGGTGGGGCA TTTACCCCGCCACTCGAGCGATGGGCGCGTTTTTGCCCTTTCCT AGCCACAACTTCAATGAGCGCATCATCACGTGTCAAGCAGTCA CTAACCATCTGACAATAGGAAGCCGCTGAGCTCGGTAAGGGTT CCTTCAAGTACGCCTGGGTTCTTGACAAGCTCAAGGCCGAGCG TGAGCGTGGTATCACCATCGATATTGCTCTCTGGAAGTTCGAG ACTCCCCGCTACTATGTCACCGTCATTGGTATGTTGTCGCTCAT GCCTCACTCTATTTCCTAGTACTAACATGTCACTCAGACGCTCC CGGTCACCGTGACTTCATAACGA
D164	ITS (ITS1)	GGGGTTTCGGGCTTACTCCAACCCCTGTGAACATACCTATACG TTGCCTCGGCGGATCAGCCCGCGCCCTGTAAAACGGGACGGCC CGCCCGAGGACCCTAAACTCTGTTTTTAGTGGAACTTCTGAGT AAAACAAACAAATAAATCAAAACTTTCAACAACGGATCTCTT GGTTCTGGCATCGATGAAGAACGCAGCAAAATGCGATAAGTA ATGTGAATTGCAGAATTCAGTGAATCATCGAATCTTTGAACGC ACATTGCGCCCGCCAGTATTCTGGCGGGCATGCCTGTTCGAGC GTCATTTCAACCCTCAAGCTCAGCTTGGTGTTGGGACTCGCGG TAACCCGCGTTCCCCAAATCGATTGGCGGTCACGTCGAGCTTC CATAGCGTAGTAATCATACACCTCGTTACTGGTAATCGTCGCG GCCACGCCGTAAAACCCCAACTTCTGAATGTTGACCTCGGATC AGGTAGGAATACCCGCTGAACTTAAGCATATCAATAAGCGGA GGAAA
D166	ß-TUBULIN (BT2)	AGTTCTCTCTGGCGAGCCGGTCTCGACAGCATGGTGTTTACAA CGGTACCTCCGAGCTCCAGCTCGAGCGTATGAGCGTCTACTTC AACGAGGTTTGTTTCATCACTCCTGCCACGAAAACACAACAAG CTCACGCGCGCCTAGGCTTCCGGTAACAAGTATGTTCCCCGTG CCGTCCTCGTCGATCTCGAGCCCGGTACCATGGACGCCGTCCG TGCCGGTCCTTTCGGACAGCTTTTCCGTCCCGACAACTTCGTTT TCGGTCAATCCGGTGCCGGAAACAACTGGGCCAAGGGTCACT ACACTGAGGGATGCACCGAACGTGAAGAAGTCATTATGATCA ACCGAATTCTCCGAGACGATCCGGCCAAGGGTCACTACACTGA GGGT

D166	TEF (EF1)	TCGACCAGCGAACCATCGAGAAGTTCGAGAAGGTTGGTTTCCATTCCCCCGATCGCACGCCCTCTACCCACCGATCCATCAGTCGAATCCGTTACGACGATTGAATATGCGCCTGTTACCCCGCT
D166	ITS (ITS1)	GGGGGATCGGGTTACTCCAACCCCTGTGACATACCTATACGTTGCCTCGGCGGATCAGCCCGCGCCCCGTAAAACGGGACGGCCCGCCCGAGGACCCCTAAACTCTGTTTTTAGTGGAACTTCTGAGTAAAACAAACAAATAAATCAAAACTTTCAACAACGGATCTCTTGGTTCTGGCATCGATGAAGAACGCAGCAAAATGCGATAAGTAATGTGAATTGCAGAATTCAGTGAATCATCGAATCTTTGAACGCACATTGCGCCCGCCAGTATTCTGGCGGGCATGCCTGTTCGAGCGTCATTTCAACCCTCAAGCTCAGCTTGGTGTTGGGACTCGCGGTAACCCGCGTTCCCCAAATCGATTGGCGGTCACGTCGAGCTTCCATAGCGTAGTAATCATACACCTCGTTACTGGTAATCGTCGCGGCCACGCCGTTAAACCCCAACTTCTGAATGTTGACCTCGGATCAGGTAGGAATACCCGCTGAACTTAAGCATATCAATAGGCGGAGGAAAA
D175	ß-TUBULIN (BT2)	GAGTTCCCTCCTCTGGCGAGCACGGCCTCGACAGCAATGGTGTCTACAATGGTACCTCCGAGCTTCAGCTCGAGCGCATGAGTGTTTACTTCAACGAGGTATGCATTAGCAGTCAATGTCAAGAGTTCACACGCTCACACATCTAGGCCTCTGGCAACAAGTATGTTCCCCGAGCCGTCCTCGTCGACCTCGAGCCTGGTACCATGGACGCCGTCCGTGCTGGTCCCTTCGGTCAGCTCTTCCGTCCCGACAACTTCGTTTTCGGTCAGTCCGGTGCTGGAAACAACTGGGCCAAGGGTCACAAAACTGAGGGT
D175	TEF (EF1)	GACTCTGGCAGTCGACCACTGTGAGTACTACCCTTGACGATGAGCTTATCGGCCATCGTAAACCCGGCCAAGACCTGGCGGGGGATTTCTCAAAGAAAACATACTGATATCGCTTCACAGACCGGTCACTTGATCTACCAGTGCGGTGGTATCGACAAGCGAACCATCGAGAAGTTCGAGAAGGTTAGTCACTTTTCCTTCTATCGCGCGTTCTTTGCCCATCGATTCCCCCCTACGACTCGAAACGTACCCGCTACCCCGCTCGAGCCCAAAAATTTTGCGATACGACCGTAATTTTTCTGGTGGGGCATTTACCCCGCCACTCGAGCGGCGCGTTTCTGCCCTCTCCCATTCCACAACCTCACTGAGCTCATCGTCACGTGTCA

		AGCAGTCACTAACCATCCGACAATAGGAAGCCGCTGAGCTCG GTAAGGGTTCCTTCAAGTACGCCTGGGTTCTTGACAAGCTCAA GGCCGAGCGTGAGCGTGGTATCACCATCGATATCGCTCTCTGG AAGTTCGAGACTCCTCGCTACTATGTCACCGTCATTGGTATGTT GTCGCTCTTACTCCGTTCTATATCTCCTATTACTAACACATCAC ATAGACGCTCCCGGTCACCGTGATTTCATCAA
D175	ITS (ITS1)	GGGGGGATCGGAGTTCACTCCCAAACCCCTGTGACATACCAAT TGTTGCCTCGGCGGATCAGCCCGCTCCCGGTAAAACGGGACGG CCCGCCAGAGGACCCCTAAACTCTGTTTCTATATGTAACTTCT GAGTAAAACCATAAATAAATCAAAACTTTCAACAACGGATCT CTTGGTTCTGGCATCGATGAAGAACGCAGCAAAATGCGATAA GTAATGTGAATTGCAGAATTCAGTGAATCATCGAATCTTTGAA CGCACATTGCGCCCGCCAGTATTCTGGCGGGCATGCCTGTTCG AGCGTCATTTCAACCCTCAAGCCCAGCTTGGTGTTGGGACTCG CGAGTCAAATCGCGTTCCCCAAATTGATTGGCGGTCACGTCGA GCTTCCATAGCGTAGTAGTAAAACCCTCGTTACTGGTAATCGT CGCGGCCACGCCGTTAAACCCCAACTTCTGAATGTTGACCTCG GATCAGGTAGGAATACCCGCTGAACTTAAGCATATCAATAGCC GGAGGAAG
D176	ß-TUBULIN (BT2)	GAGTACCTCTTCTGGCGAGCACGGCCTCGACAGCATGGTGTCT ACAACGGTACCTCCGAGCTCCAGCTCGAGCGCATGAGTGTCTA CTTCAACGAGGTATGCATTAACAGTCAATGCCAATAATTCCCA AGCTCACACAACTAGGCCTCTGGCAACAAGTATGTTCCCCGAG CCGTCCTCGTCGATCTTGAGCCTGGTACCATGGACGCCGTCCG TGCTGGTCCCTTTGGTCAGCTCTTCCGTCCCGACAACTTCGTTT TCGGTCAGTCCGGTGCTGGAAACAACTGGGCCAAGGGTCACT ACACTGAGGGTA
D176	TEF (EF1)	ACTCTGGCAGTCGACCACTGTGAGTACTACCCTCGATGATGAG CTTATCTGCCATCGAAACCCTCACCAAGACCTGGCGGGGTATT CCTCTTGAAACAAGATGCTGACATGGCTACACAGACCGGTCAC TTGATCTACCAGTGCGGTGGTATCGACAAGCGAACCATCGAGA AGTTCGAGAAGGTTAGTCACTTTCCCTTCGATCGCGCGTCCTTT GTACATCGATTTCCCCTACGACTCGAAACGTGCCCGCTACCCC

		GCTCGAGACCAAAAATTTTGCGATATGACCGTAATTTTTTGG TGGGGCATTTACCCCGCCACTCGAGCGATGGGCGCGTTTTTGC CCTTTCCTAGCCACAACTTCAATGAGCGCATCATCACGTGTCA AGCAGTCACTAACCATCTGACAATAGGAAGCCGCTGAGCTCG GTAAGGGTTCCTTCAAGTACGCCTGGGTTCTTGACAAGCTCAA GGCCGAGCGTGAGCGTGGTATCACCATCGATATTGCTCTCTGG AAGTTCGAGACTCCCCGCTACTATGTCACCGTCATTGGTATGT TGTCGCTCATGCCTCACTCTATTTCCTAGTACTAACATGTCACT CAGACGCTCCCGGTCACCGTGACTTCATCAAGAACATGATCAC TGGGTACTTCCC
D176	ITS (ITS1)	GGGGCAATAGGACTTCACTCCCAACCCCTGTGACATACCAACT GTTGCCTCGGCGGATCAGCCCGCTCCCGGTAAAACGGGACGG CCCGCCAGAGGACCCCCAAACTCTGTTTCCATGTGTAACATCT GAGTAAAACCATAAATAAATCAAAACTTTCAACAACGGATCT CTTGGTTCTGGCATCGATGAAGAACGCAGCAAAATGCGATAA GTAATGTGAATTGCAGAATTCAGTGAATCATCGAATCTTTGAA CGCACATTGCGCCCGCCAGTATTCTGGCGGGCATGCCTGTTCG AGCGTCATTTCAACCCTCAAGCCCAGCTTGGTGTTGGGACTCG CGAGTCAAATCGCGTTCCCCAAATTGATTGGCGGTCACGTCGA GCTTCCATAGCGTAGTAGTAAAACCCTCGTTACTGGTAATCGT CGCGGCCACGCCGTTAAACCCCAACTTCTGAATGTTGACCTCG GATCAGGTAGGAATACCCGCTGAACTTAAGCATATCAATAAG CGAAGTTAACAATTCCAA
D18	ITS (ITS1)	TGGCTTCGGGTTATGCCGAAGGGTAGACCTCCCACCCTTGTGT ATTATTACTTTGTTGCTTTGGCGAGCTGCCTCCGGGCCTTGTAT GCTCGCCAGAGAATACCAAAACTCTTTTTATTAATGTCGTCTG AGTACTATATAATAGTTAAAACTTTCAACAACGGATCTCTTGG TTCTGGCATCGATGAAGAACGCAGCGAAATGCGATAAGTAAT GTGAATTGCAGAATTCAGTGAATCATCGAATCTTTGAACGCAC ATTGCGCCCCTTGGTATTCCGGGGGGCATGCCTGTTCGAGCGT CATTTCAACCCTCAAGCTTAGCTTGGTATTGAGTCTATGTCAGT AATGGCAGGCTCTAAAATCAGTGGCGGCGCCGCTGGGTCCTG AACGTAGTAATATCTCTCGTTACAGGTTCTCGGTGTGCTTCTGC

		CAAAACCCAAATTTTTCTATGGTTGACCTCGGATCAGGTAGGG ATACCCGCTGAACTTAAGCATATCAATAAGCGGAGGAAGG
D181	ß-TUBULIN (BT2)	GGGTCTCTCTGGCGAGCCGGTCTCGACAGCATGGTGTTTACAA CGGTACCTCCGAGCTCCAGCTCGAGCGTATGAGCGTCTACTTC AACGAGGTTTGTTTCATCACTCCTGCCACGAAAACACAACAAG CTCACGCGCGCCTAGGCTTCCGGTAACAAGTATGTTCCCCGTG CCGTCCTCGTCGATCTCGAGCCCGGTACCATGGACGCCGTCCG TGCCGGTCCTTTCGGACAGCTTTTCCGTCCCGACAACTTCGTTT TCGGTCAATCCGGTGCCGGAAACAACTGGGCCAAGGGTCACT ACACTGAGGGTTACACCGAACGTGAAGAAGTCATTATGATCA ACCGAATTCTCCGAGACGATCCGGCCAAGGGTCACTACACTGA GGGTA
D181	TEF (EF1)	ATCCATCAGTCGAATCAGTTACGACGATTGAATATGCGCCTGT TACCCCGCTCGAGTACAAAATTTTGCGGTTCAACCGTAATTTTT TTGGTGGGGTTTCAACCCCGCTACTCGAGCGACAGACGTTTGC CCTCTTCCCACAAACTCATGTCTCGTGCATCACGTGTCCATCAG CCACTAACCACCCGACAATAGGAAGCCGCCG
D181	ITS (ITS1)	GGGGGATCGAGGTCACTCCAACCCCTGTGACATACCTATACGT TGCCTCGGCGGATCAGCCCGCGCCCCGTAAAACGGACGGCC CGCCCGAGGACCCCTAAACTCTGTTTTTAGTGGAACTTCTGAG TAAAACAAACAAATAAATCAAAACTTTCAACAACGGATCTCTT GGTTCTGGCATCGATGAAAAACGCAGCAAAATGCGATAAGTA ATGTGAATTGCAAAATTCAGTGAATCATCGAATCTTTGAACGC ACATTGCGCCCGCCAGTATTCTGGCGGGCATGCCTGTTCAAGC GTCATTTCAACCCTCAAGCTCAGCTTGGTGTTGGGACTCGCGG TAACCCGCGTTCCCCAAATCGATTGGCGGTCACGTCAAGCTTC CATAGCGTAGTAATCATACACCTCGTTACTGGTAATCGTCGCG GCCACGCCGTTAAACCCCAACTTCTGAATGTTGACCTCGGATC AGGTAGGAATACCCGCTGAACTTAAGCATATCAAAACCCGGA GGAATTT
D187	TEF (EF1)	CTCGGGTCGTGGAACCCCGCCTGGTATCTCGGGCGGGGTATTC ATCAGTCACTTCATGCTGACAATCATCTACAGACCGGTCACTT

		GATCTACCAGTGCGGTGGTATCGACAAGCGAACCATCGAGAA GTTCGAGAAGGTTGGTGACATCTCCCTCGATCGCGCCTTGCTA TTCCACATCGAATTCTCTCCCTCGCGATACGGTCTGCGCCCGCT TCTCCCGAGTCCCAAAATTTTTGCGGTCCGACCGTAATTTTTTT TGGTGGGGCATTTACCCCGCCACTCGGGCGACGTTGGACAAAG CCCTGATCCCTGCACACAAAAAACACCAAACCCTCTTGGCGCG CGCATCATCACGTGGTTCACAACAGACGCTAACCGGTCCAACA ATAGGAAGCTGCTGAGCTCGGTAAGGGTTCCTTCAAGTACGCC TGGGTCCTTGACAAGCTCAAGGCCGAGCGTGAGCGTGGTATCA CCATCGACATTGCCCTCTGGAAGTTCGAGACTCCCCGCTACTA TGTCACCGTCATTGGTATGTTGCTGTCACCTCTCTCACACATGT CTCACCACTAACAATCA
D187	ITS (ITS1)	TGGGTAACGGGTAACACTCATCACCCTGTGACATACCTAAAAC GTTGCTTCGGCGGGAACAGACGGCCCCGTAACACGGGCCGCC CCCGCCAGAGGACCCCCTAACTCTGTTTCTATTATGTTTCTTCT GAGTAAAACAAGCAAATAAATTAAAACTTTCAACAACGGATC TCTTGGCTCTGGCATCGATGAAGAACGCAGCGAAATGCGATA AGTAATGTGAATTGCAGAATTCAGTGAATCATCGAATCTTTGA ACGCACATTGCGCCCGCCAGTATTCTGGCGGGCATGCCTGTTC GAGCGTCATTACAACCCTCAGGCCCCCGGGCCTGGCGTTGGGG ATCGGCGAGGCGCCCCCTGCGGGCACACGCCGTCCCCCAAAT ACAGTGGCGGTCCCGCCGCAGCTTCCATTGCGTAGTAGCTAAC ACCTCGCAACTGGAGAGCGGCGCGGCCACGCCGTAAAACACC CAACTTCTGAATGTTGACCTCGAATCAGGTAGGAATACCCGCT GAACTTAAGCATATCAATAAGGCGGAGGAA
D192	ß-TUBULIN (BT2)	GAGTTACTCTCTGGCGAGCCGGCCTCGACAGCAATGGTGTCTA CAATGGTACCTCCGAGCTTCAGCTCGAGCGCATGAGTGTTTAC TTCAACGAGGTATGCATTAGCAGTCAATGTCAAGAGTTCACAC GCTCACACATCTAGGCCTCTGGCAACAAGTATGTTCCCCGAGC CGTCCTCGTCGACCTCGAGCCTGGTACCATGGACGCCGTCCGT GCTGGTCCCTTCGGTCAGCTCTTCCGTCCCGACAACTTCGTTTT CGGTCAGTCCGGTGCTGGAAACAACTGGGCCAAGGGTCACTA CACTGAGGGT

D192	ß-TUBULIN (BT1)	AGGGCGCTCTTCATGACAGCCGTGGTGCTCACTCTTTCCGCGCTGTCAGCGTTCCTGAGCTGACCCAGCAGATGTTCGACCCCAAGAACATGATGGCTGCTTCCGACTTCCGCAACGGTCGTTACCTGACCTGCTCTGCCATCTTCCGTGGCCGCGTCGCCATGAAGGAGGTCGAGGACCAGATGCGCAACGTTCAGAACAAGAACTCATCTTACTTCGTCGAGTGGATTCCTAACAACATCCAGACCGCTCTCTGCGCTATTCCTCCTCGGGGACTTACTATGTCCTCTACCTTTATTGGAAACTCCACCTCTATCCAGGAGCTTTTCAAGCGTGTTGGCGAGCAGTTCACTGCTATGTTCCGACGCAAGGCTTTCTTGCATTGGTACACTGGTGAGGGTATGGACGAGATGGAGTTCACTGAGGCTGAGTTCAACATGAACGATCTCGTCA
D192	TEF (EF1)	ACTCTGGCAGTCGACCACTGTGAGTACTACCCTTGACGATGAGCTTATCGGCCATCGTAAACCCGGCCAAGACCTGGCGGGGGATTTCTCAAAGAAAACATGCTGACATCGCTTCACAGACCGGTCACTTGATCTACCAGTGCGGTGGTATCGACAAGCGAACCATCGAGAAGTTCGAGAAGGTTAGTCACTTTTCCTTCTATCGCGCGTTCTTTGCCCATCGATTCCCCCCTACGACTCGAAACGTACCCGCTACCCCGCTCGAGCCCAAAAATTTTGCGATACGACCGTAATTTTTTCTGGTGGGGCATTTACCCCGCCACTCGAGCGGCGCGTTTCTGCCCTCTCCCATTCCACAACCTCACTGAGCTCATCGTCACGTGTCAAGCAGTCACTAACCATCCGACAATAGGAAGCCGCTGAGCTCGGTAAGGGTTCCTTCAAGTACGCCTGGGTTCTTGACAAGCTCAAGGCCGAGCGTGAGCGTGGTATCACCATCGATATCGCTCTCTGGAAGTTCGAGACTCCTCGCTACTATGTCACCGTCATTGGTATGTTGTCGCTCTTATTCCGTTCTATATCTTCTATTACTAACACATCACATAGACGCTCCCGGTCACCGTGATTTCATCAAGAACATGATCACTGGTACTT
D192	ITS (ITS1)	GGGACCTCGGAGCTCACTCCAACCCCTGTGACATACCTATACGTTGCCTCGGCGGATCAGCCCGCGCCCTGTAAAACGGGACGGCCCGCCCGAGGACCCTAAACTCTGTTTTTAGTGGAACTTCTGAGTAAAACAAACAAATAAATCAAAACTTTCAACAACGGATCTCTTGGTTCTGGCATCGATGAAGAACGCAGCAAAATGCGATAAGTAATGTGAATTGCAGAATTCAGTGAATCATCGAATCTTTGAACGC

		ACATTGCGCCCGCCAGTATTCTGGCGGGCATGCCTGTTCGAGC GTCATTTCAACCCTCAAGCTCAGCTTGGTGTTGGGACTCGCGG TAACCCGCGTTCCCCAAATCGATTGGCGGTCACGTCGAGCTTC CATAGCGTAGTAATCATACACCTCGTTACTGGTAATCGTCGCG GCCACGCCGTAAAACCCCAACTTCTGAATGTTGACCTCGGATC AGGTAGGAATACCCGCTGAACTTAAGCATATCAATAAGGCGG AGGAC
D196	ß-TUBULIN (BT2)	AATTTATCTCTGGCGAGCCGGTCTCGACAGCAATGGTGTTTAC AACGGTACCTCCGAGCTCCAGCTCGAGCGTATGAGCGTCTACT TCAACGAGGTTTGTTTCATCACTCCTGCCACGAAAACACAACA AGCTCACGCGCGCCTAGGCTTCCGGTAACAAGTATGTTCCCCG TGCCGTCCTCGTCGATCTCGAGCCCGGTACCATGGACGCCGTC CGTGCCGGTCCTTTCGGACAGCTTTTCCGTCCCGACAACTTCGT TTTCGGTCAATCCGGTGCCGGAAACAACTGGGCCAAGGGTCAC TACACTGAGGGT
D196	ITS (ITS1)	GGGGGCTCGGAGCTCACTCCAACCCCTGTGACATACCTATACG TTGCCTCGGCGGATCAGCCCGCGCCCCGTAAAACGGGACGGC CCGCCCGAGGACCCCTAAACTCTGTTTTTAGTGGAACTTCTGA GTAAAACAAACAAATAAATCAAAACTTTCAACAACGGATCTC TTGGTTCTGGCATCGATGAAGAACGCAGCAAAATGCGATAAG TAATGTGAATTGCAGAATTCAGTGAATCATCGAATCTTTGAAC GCACATTGCGCCCGCCAGTATTCTGGCGGGCATGCCTGTTCGA GCGTCATTTCAACCCTCAAGCTCAGCTTGGTGTTGGGACTCGC GGTAACCCGCGTTCCCCAAATCGATTGGCGGTCACGTCGAGCT TCCATAGCGTAGTAATCATACACCTCGTTACTGGTAATCGTCG CGGCCACGCCGTTAAACCCCAACTTCTGAATGTTGACCTCGGA TCAGGTAGGAATACCCGCTGAACTTAAGCATATCAATAGCGG AGGAA
D198	ß-TUBULIN (BT2)	GTGTGCTCTCTGGCGAGCCGGTCTCGACAGCAATGGTGTTTAC AACGGTACCTCCGAGCTCCAGCTCGAGCGTATGAGCGTCTACT TCAACGAGGTTTGTTTTATCTCTCCTGCCACGAAAACACAACA AGCTCACGCGCGCCTAGGCTTCCGGTAACAAGTATGTTCCCCG TGCCGTCCTCGTCGATCTCGAGCCCGGTACCATGGACGCTGTC

		CGTGCCGGTCCTTTCGGACAGCTTTTCCGTCCCGACAACTTCGT TTTCGGTCAATCCGGTGCCGGAAACAACTGGGCCAAGGGTCAC TACACTGAGGGTA
D198	ITS (ITS1)	GGGGGCAACGGAGCTAACTCCAAACCCCTGTGACATACCTAT ACGTTGCCTCGGCGGATCAGCCCGCGCCCTGTAAAACGGGAC GGCCCGCCCGAGGACCCTAAACTCTGTTTTTAGTGGAACTTCT GAGTAAAACAAACAAATAAATCAAAACTTTCAACAACGGATC TCTTGGTTCTGGCATCGATGAAGAACGCAGCAAAATGCGATAA GTAATGTGAATTGCAGAATTCAGTGAATCATCGAATCTTTGAA CGCACATTGCGCCCGCCAGTATTCTGGCGGGCATGCCTGTTCG AGCGTCATTTCAACCCTCAAGCTCAGCTTGGTGTTGGGACTCG CGGTAACCCGCGTTCCCCAAATCGATTGGCGGTCACGTCGAGC TTCCATAGCGTAGTAATCATACACCTCGTTACTGGTAATCGTC GCGGCCACGCCGTAAAACCCCAACTTCTGAATGTTGACCTCGG ATCAGGTAGGAATACCCGCTGAACTTAAGCAGATCAATAGGC GGAGGTAC
D199	ITS (ITS1)	GGGCTTCGATACTATGGTGTTGGTTGTAGCTGGCTCCTCGGAG CAATGTGCACGCCCGCCATTTTTATCTTTCCACCTGTGCACCGA CTGTAGGTCTGGATACCTCTCGCCTCCGGGCGGATGCGAGGGT TGCTCGTAAGGGCTTCCCTTGAACTTCCAGGCTCTACGTCTTTT TACACACCCCAATAGTATGATGCAGAATGTAGTCAATGGGCTT CTCAGCCTATAAAACACTATACAACTTTCAGCAACGGATCTCT TGGCTCTCGCATCGATGAAGAACGCAGCGAAATGCGATAAGT AATGTGAATTGCAGAATTCAGTGAATCATCGAATCTTTGAACG CACCTTGCGCTCCTTGGTATTCCGAGGAGCATGCCTGTTTGAG TGTCATTAAATTCTCAACCTCACCAGTTTTCTGAACTGACTGAG GCTTGGATGTGGGGGTTTGTGCAGGCTGCCTCACGGCGGTCTG CTCCCCTGAAATGCATTAGCGAGGTTCATGCTGGACCTCCGTC TATTGGTGTGATAATTATCTACGCCGTGGACGAGGATACAGAC TCGCTTCTAATCGTCCGCGAGGACAATACCTTGACAATTTGAC CTCAAATCAGGTAGGACTACCCACTGTACTTAAGCATATAAAT AAGCGGTAGGTGTGAGCTGGGTTCCCCGAGCAATTTGGCACCC CCCCTTTTTTCTTTTCCTGTTCCCCACAGGGAGTCCGGGAACCC

		TTCCCCCCCGCGGGAATGCCAGGGGTTGTCTGAAGGGGCTTCC TTGAAATCCCGGCCCTTCATTTTTTTACCACCCCCATAGTATG AATGCGAAAGGGAGGCCATGGGGCCTTCCTACCCAGTAAAAT ATGAGCTTCGACAGGAATCTTGGCTCGTCAGTAGAAGCCCGAA TGGTTAACATGGGATGTGCAATCGTGATGCGATTGAAGCTGCT TGTAATCGCAGAGCTGAGGCTAAGTTACCGTTCAATCAGCTGA TGGTTGAGCTCAGGGTCAGCCAGATGAACT
D20	ß-TUBULIN (BT2)	AGGTACTCTCTGGCGAGCCGGTCTCGACAGCATGGTGTTTACA ACGGTACCTCCGAGCTCCAGCTCGAGCGTATGAGCGTCTACTT CAACGAGGTTTGTTTCATCACTCCTGCCACGAAAACACAACAA GCTCACGCGCGCCTAGGCTTCTGGTAACAAGTATGTTCCCCGT GCCGTCCTCGTCGATCTCGAGCCCGGTACCATGGACGCCGTCC GTGCCGGTCCTTTCGGACAGCTTTTCCGTCCCGACAACTTCGTT TTCGGTCAATCCGGTGCCGGAAACAACTGGGCCAAGGGTCACT ACACTGAGGGTA
D20	TEF (EF1)	TCTTCCAGAATATTTGCTGACAAGATTGCATAGACCGGTCACT TGATCTACCAGTGCGGTGGTATCGACAAGCGAACCATCGAGA AGTTCGAGAAGGTTGGTTTCCATTCCCCCGATCGCACGCCCTC TACCCACCGATC
D20	ITS (ITS1)	TGGGATCCGAGTAACTCCCAACCCCTGTGACATACCTATACGT TGCCTCGGCGGATCACCCGCGCCCCGTAAAACGGGACGGCCC GCCCGAGGACCCCTAAACTCTGTTTTTAGTGGAACTTCTGATT AAAACAAACAAATAAATCAAAACTTTCAACAACGGATCTCTT GGTTCTGGCATCGATGAAAAACGCACCAAAATGCGATAAGTA ATGTGAATTGCAAAATTCAGTGAATCATCGAATCTTTGAACGC ACATTGCGCCCGCCAGTATTCTGGCGGGCATGCCTGTTCGAGC GTCATTTCAACCCTCAAGCTCAGCTTGGTGTTGGGACTCGCGG TAACCCGCGTTCCCCAAATCGATTGGCGGTCACGTCAAGCTTC CATAGCGTAGTAATCATACACCTCGTTACTGGTAATCGTCGCG GCCACGCCGTTAAACCCCAACTTCTGAATGTTGACCTCGGATC AGGTAGGAATACCCGCTGAACTTAAGCATATCAATAACCGGA GGAAAC

D200	ITS (ITS1)	GGGCTAATCGGTGGGGACTCGCCCCTTCGAGATAGCACCCTTT GTTTATGAGCACCTCTCGTTTCCTCGGCAGGCTCGCCTGCCAA CGGGGACCCACCACAAACCCATTGTAGTACAAGAAGTACACG TCTGAACAAAACAAAACAAACTATTTACAACTTTCAACAACGG ATCTCTTGGTTCTGGCATCGATGAAGAACGCAGCGAAATGCGA TAAGTAGTGTGAATTGCAGAATTCAGTGAATCATCGAATCTTT GAACGCACATTGCGCCCTTTGGTATTCCTTAGGGCATGCCTGT TCGAGCGTCATTTCAACCCTCAAGCCTAGCTTGGTGTTGGGCG TCTGTCCCGCCTCCGCGCGCCTGGACTCGCCTCAAAAGCATTG GCGGCCGGTTCCCAGCAGGCCACGAGCGCAGCAGAGCAAGCG CTGAAGTGGCTGCGGGTCGGCGCACCATGAGCCCCCCACACC AGAATTTTGACCTCGGATCAGGTAGGGATACCCGCTGAACTTA AGCATATCAATAAGCGGAGGAA
D210	ITS (ITS1)	GGGGAGTTCCGGCTCACTCCAAACCCCTGTGACATACCTATAC GTTGCCTCGGCGGATCAGCCCGCGCCCTGTAAAAAGGGACGG CCCGCCCGAGGACCCTAAACTCTGTTTTAGTGGAACTTCTGA GTAAAACAAACAAATAAATCAAAACTTTCAACAACGGATCTC TTGGTTCTGGCATCGATGAAGAACGCAGCAAAATGCGATAAG TAATGTGAATTGCAGAATTCAGTGAATCATCGAATCTTTGAAC GCACATTGCGCCCGCCAGTATTCTGGCGGGCATGCCTGTTCGA GCGTCATTTCAACCCTCAAGCTCAGCTTGGTGTTGGGACTCGC GGTAACCCGCGTTCCCCAAATCGATTGGCGGTCACGTCGAGCT TCCATAGCGTAGTAATCATACACCTCGTTACTGGTAATCGTCG CGGCCACGCCGTAAAACCCCAACTTCTGAATGTTGACCTCGGA TCAGGTAGGAATACCCGCTGAACTTAAGCATATCAATAGGCCG GAGGAAT
D210	TEF (EF1)	GGTATCGACAAGCGAACCATCGAGAAGTTCGAGAAGGTTGGT TTACATTTCCCTCGATCGCACGCCCTCTCCCCACCGATCCATCA CTCGAATCAGTCTCGACTGAATATGCGCCTGTTACCCCGCTCG AGTACAAAATTTTGCGGTTCAACCGTAATTTTTTGGTGGGGTC CATACCCCGCTACTCGAATGACAGGCGCTTGCCCTCTTCCCAC ATCATGTGCATCACGTGTCATTCAGCCAACCAGTAACTAACCA CCCGACAATAGGAAGCCGCCGAGCTCGGTAAGGGTTCCTTCA

		AGTACGCCTGGGTTCTTGACAAGCTCAAGGCCGAGCGTGAGC GTGGTATCACCATCGATATCGCTCTCTGGAAGTTCGAGACTCC TCGCTACTATGTCACCGTCATTGGTATGTCTCATCAATCACACT TGACCTTCTCATACTAACATGTATCTCAGACGCTCCCGGTCAC CGTGATTTCATCAAGAACATGATCACTGGTACTTCCCA
D220	ß-TUBULIN (BT2)	GGGTCCTCTCTGGCGAGCCGGCCTCGACAGCAATGGTGTCTAC AACGGTACCTCCGAGCTCCAGCTCGAGCGCATGAGTGTCTACT TCAACGAGGTATGCATTAACAGTCAATGCCAATAATTCCCAAG CTCACACAACTAGGCCTCTGGCAACAAGTATGTTCCCCGAGCC GTCCTCGTCGATCTTGAGCCTGGTACCATGGACGCCGTCCGTG CTGGTCCCTTTGGTCAGCTCTTCCGTCCCGACAACTTCGTTTTC GGTCAGTCCGGTGCTGGAAACAACTGGGCCAAGGGTCAATAC ACTGAGGGTA
D220	TEF (EF1)	GGCAGTCGACCACTGTGAGTACTACCCTCGATGATGAGCTTAT CTGCCATCGAAACCCTCACCAAGACCTGGCGGGGTATTCCTCT TGAAACAAGATGCTGACATGGCTACACAGACCGGTCACTTGAT CTACCAGTGCGGTGGTATCGACAAGCGAACCATCGAGAAGTT CGAGAAGGTTAGTCACTTTCCCTTCGATCGCGCGTCCTTTGTAC ATCGATTTCCCCTACGACTCGAAACGTGCCCGCTACCCCGCTC GAGACCAAAAATTTTGCGATATGACCGTAATTTTTTGGGGCA TTTACCCCGCCACTCGAGCG
D220	ITS (ITS1)	GGGGATCGGCATCACTCCAACCCCTGTGACATACCAATTGTTG CCTCGGCGGATCAGCCCGCTCCCGGTAAAACGGGACGGCCCG CCAGAGGACCCCCAAACTCTGTTTCTATATGTAACTTCTGAGT AAAACCATAAATAAATCAAAACTTTCAACAACGGATCTCTTGG TTCTGGCATCGATGAAGAACGCAGCAAAATGCGATAAGTAAT GTGAATTGCAGAATTCAGTGAATCATCGAATCTTTGAACGCAC ATTGCGCCCGCCAGTATTCTGGCGGGCATGCCTGTTCGAGCGT CATTTCAACCCTCAAGCCCAGCTTGGTGTTGGGACTCGCGAGT CAAATCGCGTTCCCCAAATTGATTGGCGGTCACGTCGAGCTTC CATAGCGTAGTAGTAAAACCCTCGTTACTGGTAATCGTCGCGG CCACGCCGTTAAACCCCAACTTCTGAATGTTGACCTCGGATCA GGTAGGAATACCCGCTGAACTTAAGCATATCAATAGGCGGAG

		GAAA
D221	ß-TUBULIN (BT1)	GGCCCACTTTTAACCAGCATGCTCACGTGCTGCTCCTCTATCG GCGCAGTCACCGTTCCTGAGCTGACCCAACAGATGCTCCACCC CAAGAACATGATGGCTGCTTCCGACTTCCGCCACGGACGCTAC CTGACCTGTGCTGCCATCTTCCGAGGACGCCCGTCGATGAAAG AAGACGATAAGTAAAAACTTTACGCCCCCGTGGCCGTGCGTCG TACAACGAGGTCGAGGACCCGAACAACATCCACACCGCCGTT TGCCTTCTCCGCCTCTTGATTTGAAGATGGCTGCCTCTTTCATC GGTAACTCGACCGCTCTCCCCAGCTATTAAACTGTCCTCTACA CTATTTACAGACTTGTTCCCCAGGAGGCTTTTTGGATTGTGTT GTTCATAACTTAAATGGCTCAGCCGGACACCAGCGGTTCTTTG GGTGGAATCTATCTATTCAAAAAATGTTTATGTTGTTTGATTGT TTGTTCATTTCAAGTACACAGCACATCACATGGACGAGATGGA GTTCACTGAGGCCGAATTCAACAAGAACGATCTCATCAA
D221	ITS (ITS1)	GGGCTTCGGTTCACTCCCAACCCCTGTGACATACCACTTGTTG CCTCGGCGGATCAGCCCGCTCCCGGTAAAACGGGACGGCCCG CCAGAGGACCCCTAAACTCTGTTTCTATATGTAACTTCTGAGT AAAACCATAAATAAATCAAAACTTTCAACAACGGATCTCTTGG TTCTGGCATCGATGAAGAACGCAGCAAAATGCGATAAGTAAT GTGAATTGCAGAATTCAGTGAATCATCGAATCTTTGAACGCAC ATTGCGCCCGCCAGTATTCTGGCGGGCATGCCTGTTCGAGCGT CATTTCAACCCTCAAGCACAGCTTGGTGTTGGGACTCGCGTTA ATTCGCGTTCCCCAAATTGATTGGCGGTCACGTCGAGCTTCCA TAGCGTAGTAGTAAAACCCTCGTTACTGGTAATCGTCGCGGCC ACGCCGTTAAACCCCAACTTCTGAATGTTGACCTCGGATCAGG TAGGAATACCCGCTGAACTTAAGCATATCAATAGGCGGGAGG AAC
D225	ß-TUBULIN (BT2)	AGTACTCTCTGGCGAGCCGGCCTCGACAGCATGGTGTCTACAA CGGTACCTCCGAGCTCCAGCTCGAGCGCATGAGTGTCTACTTC AACGAGGTATGCCTTAACAGTCAATGCCAACGATCCACAAGCT CACACAACTAGGCCTCTGGCAACAAGTATGTTCCCCGAGCCGT CCTCGTCGATCTTGAGCCTGGTACCATGGACGCTGTCCGTGCT GGTCCCTTCGGTCAGCTCTTCCGTCCCGACAACTTCGTTTTCGG

		TCAGTCCGGTGCTGGAAACAACTGGGCCAAGGGTCACTACACT GAGGGTA
D225	TEF (EF1)	ACATGGCAGTCGACCACTGTGAGTACTACCCTGGACGATGAGC TTATCTGCCATCGTGATCCTGACCAAGATCTGGCGGGGTACAT CTTGGAAGACAATATGCTGACATCGCTTCACAGACCGGTCACT TGATCTACCAGTGCGGTGGTATCGACAAGCGAACCATCGAGA AGTTCGAGAAGGTTAGTCACTTTCCCTTCGATCGCGCGTCCTCT GCCCACCGATTTCACTTGCGATTCGAAACGTGCCTGCTACCCC GCTCGAGACCAAAAATTTTGCGATATGACCGTAATTTTTTTGG TGGGGCATTCACCCCGCCACTCGAGCGATGGGCGCGTTTTTGC CCTCTCCTGTCCACAACCTCAATGAGCGCATTGTCACGTGTCA AGCAGCGACTAACCATTCGACAATAGGAAGCCGCTGAGCTCG GTAAGGGTTCCTTCAAGTACGCCTGGGTTCTTGACAAGCTCAA GGCCGAGCGTGAGCGTGGTATCACCATCGATATTGCTCTCTGG AAGTTCGAGACTCCTCGCTACTATGTCACCGTCATTGGTATGTT GTCGCTCATACCTCATCCTACTTCCTCATACTAACACATCATTC AGACGCTCCCGGTCACCGTGATTTCAACAAAA
D225	ITS (ITS1)	GGGGTATCCGGCCTTGGGGTCCAACTCTGTGGCGGTACCTATA CGTTGCCTCGGCGGATCAGCCCGCGCCCTGTAAAACGGGACG GCCCGCCCGAGGACCCTAAACTCTGTTTTTAGTGGAACTTCTG AGTAAAACAAACAAATAAATCAAAACTTTCAACAACGGATCT CTTGGTTCTGGCATCGATGAAGAACGCAGCAAAATGCGATAA GTAATGTGAATTGCAGAATTCAGTGAATCATCGAATCTTTGAA CGCACATTGCGCCCGCCAGTATTCTGGCGGGCATGCCTGTTCG AGCGTCATTTCAACCCTCAAGCTCAGCTTGGTGTTGGGACTCG CGGTAACCCGCGTTCCCCAAATCGATTGGCGGTCACGTCGAGC TTCCATAGCGTAGTAATCATACACCTCGTTACTGGTAATCGTC GCGGCCACGCCGTAAAACCCCAACTTCTGAATGTTGACCTCGG ATCAGGTAGGAATACCCGCTGAACTTAAGCATATCAATAAGC AGATGAAAC
D227	ß-TUBULIN	GGGGCATCTCTGGCGAGCCGGTCTCGACAGCAATGGTGTTTAC AACGGTACCTCCGAGCTCCAGCTCGAGCGTATGAGCGTCTACT TCAACGAGGTTTGTTTCATCACTCCTGCCACGAAAACACAACA

	(BT2)	AGCTCACGCGCGCCTAGGCTTCCGGTAACAAGTATGTTCCCCG TGCCGTCCTCGTCGATCTCGAGCCCGGTACCATGGACGCCGTC CGTGCCGGTCCTTTCGGACAGCTTTTCCGTCCCGACAACTTCGT TTTCGGTCAATCCGGTGCCGGAAACAACTGGGCCAAGGGACG AAAAACTGAGGGTAA
D227	ß-TUBULIN (BT1)	GACGCCTCATCATGACAGCCGTGGTGCTCACTCTTTCCGCGCT GTCAGCGTTCCTGAGCTGACCCAGCAGATGTTCGACCCCAAGA ACATGATGGCTGCTTCCGACTTCCGCAACGGTCGTTACCTGAC CTGTTCTGCCATCTTCCGTGGCCGCGTCGCCATGAAGGAGGTC GAGGACCAGATGCGCAACGTTCAGAACAAGAACTCATCTTATT TCGTCGAGTGGATCCCTAACAACATCCAGACCGCTCTCTGCGC TATTCCTCCTCGGGGACTTACTATGTCCTCTACCTTCATTGGAA ACTCCACCTCTATCCAGGAGCTTTTCAAGCGTGTTGGCGAGCA GTTTACTGCTATGTTCCGACGCAAGGCTTTCTTGCATTGGTACA CTGGTGAGGGTATGGACGAGATGGAGTTCACTGAGGCTGAGT TCAACATGAACGATCTCATCA
D227	ITS (ITS1)	AGGGGGATCGGGCTCACTCCAACCCCTGTGACATACCTATACG TTGCCTCGGCGGATCAGCCCGCGCCCCGTAAAACGGGACGGC CCGCCCGAGGACCCCTAAACTCTGTTTTAGTGGAACTTCTGA GTAAAACAAACAAATAAATCAAAACTTTCAACAACGGATCTC TTGGTTCTGGCATCGATGAAGAACGCAGCAAAATGCGATAAG TAATGTGAATTGCAGAATTCAGTGAATCATCGAATCTTTGAAC GCACATTGCGCCCGCCAGTATTCTGGCGGGCATGCCTGTTCGA GCGTCATTTCAACCCTCAAGCTCAGCTTGGTGTTGGGACTCGC GGTAACCCGCGTTCCCCAAATCGATTGGCGGTCACGTCGAGCT TCCATAGCGTAGTAATCATACACCTCGTTACTGGTAATCGTCG CGGCCACGCCGTTAAACCCCAACTTCTGAATGTTGACCTCGGA TCAGGTAGGAATACCCGCTGAACTTAAGCATATCAATAAGCG GAGGAAA
D23	ß-TUBULIN	AGGGCCTTCTCTGGCGAGCACGGTCTCGACAGCAATGGTGTTT ACAACGGTACCTCCGAGCTCCAGCTCGAGCGTATGAGCGTCTA CTTCAACGAGGTTTGTTTCATCACTCCTGCCACGAAAACACAA CAAGCTCACGCGCGCCTAGGCTTCTGGTAACAAGTATGTTCCC

	(BT2)	CGTGCCGTCCTCGTCGATCTCGAGCCCGGTACCATGGACGCCG TCCGTGCCGGTCCTTTCGGACAGCTTTTCCGTCCCGACAACTTC GTTTTCGGTCAATCCGGTGCCGGAAACAACTGGGCCAAGGGTC ACTACACTGAGGGTA
D23	ITS (ITS1)	GGGGGGTACGGAGCTCACTCCAACCCCTGTGACATACCTATAC GTTGCCTCGGCGGATCAGCCCGCGCCCCGTAAAACGGGACGG CCCGCCCGAGGACCCCTAAACTCTGTTTTTAGTGGAACTTCTG AGTAAAACAAACAAATAAATCAAAACTTTCAACAACGGATCT CTTGGTTCTGGCATCGATGAAGAACGCAGCAAAATGCGATAA GTAATGTGAATTGCAGAATTCAGTGAATCATCGAATCTTTGAA CGCACATTGCGCCCGCCAGTATTCTGGCGGGCATGCCTGTTCG AGCGTCATTTCAACCCTCAAGCTCAGCTTGGTGTTGGGACTCG CGGTAACCCGCGTTCCCCAAATCGATTGGCGGTCACGTCGAGC TTCCATAGCGTAGTAATCATACACCTCGTTACTGGTAATCGTC GCGGCCACGCCGTTAAACCCCAACTTCTGAATGTTGACCTCGG ATCAGGTAGGAATACCCGCTGAACTTAAGCATATCAATAAGC GGAGGAAG
D232	ß-TUBULIN (BT2)	GCGAGCATGGCCTCGACGGCTCCGGTGTCTACAACGGCACCTC GGACCTCCAGCTCGAGCGCATGAACGTCTACTTCAACGAGGTA CTAGAAATGACACTTTCCCCTTAGACGGACTGCGAGTGCTGAC CTTCCACAGGCCTCTGGCAACAAGTTCGTTCCCCGTGCCGTCC TCGTCGATTTGGAGCCCGGTACAATGGACGCTGTCCGCGCTGG TCCCTTTGGTCAGCTCTTCCGTCCCGACAACTTCGTCTTCGGCC AGTCTGGTGCTGGTAACAACTGGGCCAAGGGTCACAACAA
D234	ß-TUBULIN (BT2)	GAGCCGGCCTCGACAGCGATGGCCAGTACGTTTCTCGCCTCCC CGTCCTCCCGTCCTCCCCCTCCCTGCCGTCGTCGCGTCACGGCG GTGCAGAGAAGAAAAAACCAAGACACGATGCGATGGAAGCA GGAAAGCCGTCCACTGACCATGCCCTCACGACAGGTACAACG GCACCTCGGAGCTCCAGCTCGAGCGCATGAGCGTCTACTTCAA CGAGGCCTCGGGCAACAAGTACGTTCCCCGTGCCGTCCTCGTC GATCTCGAGCCCGGTACCATGGACGCCGTCCGCGCCGGTCCTT TCGGCCAGCTCTTCCGCCCCGATAACTTCGTTTTCGGCCAGTCC GGTGCTGGCAACAACTGGGCCAAGGGTCACTACACTGAGGGT

		A
D235	ITS (ITS1)	GGGGGGTTCCTTGGAGTGTAGGCTTTGCCTGCTATCTCTTACCC ATGTCTTTTGAGTACCTTACGTTTCCTCGGTGGGTTCGCCCACC GATTGGACAAATTTAAACCCTTTGCAGTTGAAATCAGCGTCTG AAAAAACTTAATAGTTACAACTTTCAACAACGGATCTCTTGGT TCTGGCATCGATGAAGAACGCAGCGAAATGCGATAAGTAGTG TGAATTGCAGAATTCAGTGAATCATCGAATCTTTGAACGCACA TTGCGCCCCTTGGTATTCCATGGGGCATGCCTGTTCGAGCGTC ATTTGTACCTTCAAGCTCTGCTTGGTGTTGGGTGTTTGTCTCCT GTAGACTCGCCTTAAAACAATTGGCAGCCGGCGTATTGATTTC GGAGCGCAGTACATCTCGCGCTTTGCACTCATAACGACGACAT CCAAAAGTACATTTTTACACTCTTGACCTCGGATCAGGTAGGG ATACCCGCTGAACTTAAGCATATCAATAAGCGGAGGAA
D236	ß-TUBULIN (BT2)	GCGAGCATGGCCTCGACGGCTCCGGTGTCTACAACGGCACCTC GGACCTCCAGCTCGAGCGCATGAACGTCTACTTCAACGAGGTA CTAGAAATGACACTTTTCCCATAGACGGACTGCGAGTGCTGAC CTTCCACAGGCCTCTGGCAACAAGTTCGTTCCCCGTGCCGTCC TCGTCGATTTGGAGCCCGGCACAATGGACGCTGTCCGCGCTGG TCCCTTTGGTCAGCTCTTCCGTCCCGACAACTTCGTCTTCGGCC AGTCTGGTGCTGGTAACAACTGGGCCAAGGGTCACTACACTGA GGGT
D239	ß-TUBULIN (BT2)	CACGGTCTCGACAGCAATGGTGTTTACAACGGTACCTCCGAGC TCCAGCTCGAGCGTATGAGCGTCTACTTCAACGAGGTATGTTT CATCACTCCTGCCACAAAAACACAACAAGCTCACGCGCGCCTA GGCTTCCGGTAACAAGTATGTTCCCCGTGCCGTCCTCGTCGAT CTCGAGCCCGGTACCATGGACGCCGTCCGTGCCGGTCCTTTCG GACAGCTTTTCCGTCCCGACAACTTCGTTTTCGGTCAATCCGGT GCCGGAAACAACTGGGCCAAGGGTCACTACACTGAGGGTA
D253	ß-TUBULIN (BT2)	CAGCATGGTGTTTACAACGGTACCTCCGAGCTCCAGCTCGAGC GTATGAGCGTCTACTTCAACGAGGTATGTTTCATCACTCCTGC CACAAAAACACAACAAGCTCACGCGCGCCTAGGCTTCCGGTA ACAAGTATGTTCCCCGTGCCGTCCTCGTCGATCTCGAGCCCGG

		TACCATGGACGCCGTCCGTGCCGGTCCTTTCGGACAGCTTTTC CGTCCCGACAACTTCGTTTTCGGTCAATCCGGTGCCGGAAACA ACTGGGCCAAGGGTCACTACACTGAGGGTATGGAACCATGGA CGCTGTCCGCGCTGGACCTTTCGGCCAGCTTTTCCGTCCCGAC AACTTCGTGTTCGGCCAGTCCGGTGCTGGTAACAACTGGGCCA AGGGTCACTACACTGAGGGTA
D254	ITS (ITS1)	GGGGAATTAGTAACGGTGTGGTCGCGGCCTCCGGGGGTTCCCC CCCGGGCGGTAGAGGTAACACTCTCACGCGCCACATGTCTGAA TCCTTTTTTTACGAGCACCTTTCGTTCTCCTTCGGTGGGGCAAC CTGCCGCTGGAACTTATCAAAACCTTTTTTGCATCTAGCATTAC CTGTTCAGATACAAACAATCGTTACAACTTTCAACAATGGATC TCTTGGCTCTGGCATCGATGAAGAACGCAGCGAAATGCGATA AGTAGTGTGAATTGCAGAATTCAGTGAATCATCGAATCTTTGA ACGCACATTGCGCCCCTTGGTATTCCATGGGGCATGCCTGTTC GAGCGTCATCTACACCCTCAAGCTCTGCTTGGTGTTGGGCGTC TGTCCCGCCTCTGCGCGTGGACTCGCCCCAAATTCATTGGCAG CGGTCTTTGCCTCCTCTCGCGCAGCACATTGCGCTTCAGAGGG GCGTGGGCCGCGTCCACGAAGCAACATTACCGTCTTTGACCTC GGATCAGGTAGGGATACCCGCTGAACTTAAGAATATCAATAA GCGGAGGAA
D255	ITS (ITS1)	GGGAAAACGGACTTACGAGCTCCGGCTCGACTCTCCCACCCTT TGTGAACGTACCTCTGTTGCTTTGGCGGCTCCGGCCGCCAAAG GACCTTCAAACTCCAGTCAGTAAACGCAGACGTCTGATAAACA AGTTAATAAACTAAAACTTTCAACAACGGATCTCTTGGTTCTG GCATCGATGAAGAACGCAGCGAAATGCGATAAGTAATGTGAA TTGCAGAATTCAGTGAATCATCGAATCTTTGAACGCACATTGC GCCCCTTGGTATTCCGGGGGGCATGCCTGTTCGAGCGTCATTA CAACCCTCAAGCTCTGCTTGGAATTGGGCACCGTCCTCACTGC GGACGCGCCTCAAAGACCTCGGCGGTGGCTGTTCAGCCCTCAA GCGTAGTAGAATACACCTCGCTTTGGAGCGGTTGGCGTCGCCC GCCGGACGAACCTTCTGAACTTTTCTCAAGGTTGACCTCGGAT CAGGTAGGGATACCCGCTGAACTAAAG

D255	ß-TUBULIN (BT2)	GGGTGTGTGGTGCAAACTCCTGCTCTGCGCCCCCGCTGACGGAAGCGACACCATAGGCAGACCATCTCCGGCGAGCACGGCCTGGATGGCTCCGGTGTGTAAGTGTGCGCCTTCTCCGCCGCGCATCGCAATCGCTGACCCGTAGCAGCTACAATGGCACCTCGGACCTCCAACTGGAGCGCATGAACGTCTACTTCAACGAGGTACTCTCTCCATAATTAGACAAACACGTAAAGTATGGCAATCTTCTGAACGCGCAGCAGGCGTCCAACAACAAGTACGTTCCTCGTGCTGTCCTCGTCGACCTCGAGCCCGGCACCATGGATGCCGTCCGCGCCGGCCCCTTCGGTCAGCTCTTCCGCCCCGACAACTTCGTCTTCGGCCAGTCTGGTGCCGGTAACAACTGGGCCGAGACTCACTACACTGAGGGTA
D26	ITS (ITS1)	GGGGGATCGGGCTCACTCCAACCCAATGTGAACGTTACCAAACTGTTGCCTCGGCGGGATCTCTGCCCCGGGTGCGTCGCAGCCCCGGACCAAGGCGCCCGCCGGAGGACCAACCAAAACTCTTATTGTATACCCCCTCGCGGGTTTTTACTATCTGAGCCATCTCGGCGCCCCTCGTGGGCGTTTCGAAAATGAATCAAAACTTTCAACAACGGATCTCTTGGTTCTGGCATCGATGAAGAACGCAGCGAAATGCGATAAGTAATGTGAATTGCAGAATTCAGTGAATCATCGAATCTTTGAACGCACATTGCGCCCGCCAGTATTCTGGCGGGCATGCCTGTCCGAGCGTCATTTCAACCCTCGAACCCCTCCGGGGGGTCGGCGTTGGGGATCGGCCCTTTACGGGGCCGGCCCCGAAATACAGTGGCGGTCTCGCCGCAGCCTCTCCTGCGCAGTAGTTTGCACACTCGCATCGGGAGCGCGGCGCGTCCACAGCCGTTAAACACCCCAAACTTCTGAAATGTTGACCTCGGATCAGGTAGGAATACCCGCTGAACTTAAGCATATCAATAAGGCGGAGGAAATC
D263	ß-TUBULIN (BT2)	ACGGCTCTGGTGTCTACAACGGCACCTCAGACCTCCAGCTCGAACGCATGAACGTCTACTTCAACGAGGTACTAGAACTGACACGCTATCCTATATCGGACTGCGAGTGCTGACCTCTTACAGGCCTCCGGCAACAAGTTCGTTCCCCGTGCCGTCCTCGTCGATTTGGAGCCCGGAACAATGGACGCGGTTCGCGCTGGCCCCTTCGGTCAGCTCTTCCGCCCCGACAACTTCGTCTTCGGCCAGTCTGGTGCTGGTAACAACTGGGCCAAGGGTCACTACAC

D277	ß-TUBULIN (BT2)	GAAGCATGGTGTTTACAACGGTACCTCCGAGCTCCAGCTCGAGCGTATGAGCGTCTACTTCAACGAGGTATGTTTCATCACTCCTGCCACAAAAACACAACAAGCTCACGCGCGCCTAGGCTTCCGGTAACAAGTATGTTCCCCGTGCCGTCCTCGTCGATCTCGAGCCCGGTACCATGGACGCCGTCCGTGCCGGTCCTTTCGGACAGCTTTTCCGTCCCGACAACTTCGTTTTCGGTCAATCCGGTGCCGGAAACAACTGGGCCAAGGGTCACTACACTGAGGGTA
D37	ITS (ITS1)	TGGCACGGGCTCACTCCCAACCCAATGTGAACCATACCAAACTGTTGCCTCGGCGGGGTCACGCCCCGGGTGCGTCGCAGCCCCGGAACCAGGCGCCCGCCGGAGGGACCAACCAAACTCTTTTCTGTAGTCCCCTCGCGGACGTTATTTCTTACAGCTCTGAGCAAAAATTCAAAATGAATCAAAACTTTCAACAACGGATCTCTTGGTTCTGGCATCGATGAAGAACGCAGCGAAATGCGATAAGTAATGTGAATTGCAGAATTCAGTGAATCATCGAATCTTTGAACGCACATTGCGCCCGCCAGTATTCTGGCGGGCATGCCTGTCCGAGCGTCATTTCAACCCTCGAACCCCTCCGGGGGGTCGGCGTTGGGGATCGGGAACCCCTAAGACGGGATCCCGGCCCCGAAATACAGTGGCGGTCTCGCCGCAGCCTCTCCTGCGCAGTAGTTTGCACAACTCGCACCGGGAGCGCGGCGCGTCCACGTCCGTAAAACACCCAACTTCTGAAATGTTGACCTCGGATCAGGTAGGAATACCCGCTGAACTTAAGCATATCAATAAGCCGGAGGAAG
D41	ß-TUBULIN (BT2)	AGTACTCTCTGGCGAGCCGGTCTCGACAGCAATGGTGTTTACAACGGTACCTCCGAGCTCCAGCTCGAGCGTATGAGCGTCTACTTCAACGAGGTTTGTTTCATCACTCCTGCCACGAAAACACAACAAGCTCACGCGCGCCTAGGCTTCCGGTAACAAGTATGTTCCCCGTGCCGTCCTCGTCGATCTCGAGCCCGGTACCATGGACGCCGTCCGTGCCGGTCCTTTCGGACAGCTTTTCCGTCCCGACAACTTCGTTTTCGGTCAATCCGGTGCCGGAAACAACTGGGCCAAGGGTCAATACACTGAGGGTAA
D41	ß-TUBULIN	GGGCTGGTCATCATGAAGCCGTGGTGCTCACTCTTTCCGCGCTGTCAGCGTTCCTGAGCTGACCCAGCAGATGTTCGACCCCAAGAACATGATGGCTGCTTCCGACTTCCGCAACGGTCGTTACCTGACCTGTTCTGCCATCTTCCGTGGCCGCGTCGCCATGAAGGAGGTC

	(BT1)	GAGGACCAGATGCGCAACGTTCAGAACAAGAACTCATCTTATT TCGTCGAGTGGATCCCTAACAACATCCAGACCGCTCTCTGCGC TATTCCTCCTCGGGGACTTACTATGTCCTCTACCTTTATTGGAA ACTCCACCTCTATCCAGGAGCTTTTCAAGCGTGTTGGCGAGCA GTTTACTGCTATGTTCCGACGCAAGGCTTTCTTGCATTGGTACA CTGGTGAGGGTATGGACGAGATGGAGTTCACTGAGGCTGAGT TCAACATGAAAAAATCTCATCA
D41	TEF (EF1)	CAACTTGAATATTTGCTGACAAGATTGCATAGACCGGTCACTT GATCTACCAGTGCGGTGGTATCGACAAGCGAACCATCGAGAA GTTCGAGAAGGTTGGTTTCCATTTCCCCGATCGCACGCCGTCT ACCCACCGATCCATCAGTCGAATCAGTTACGACGATTGAATAT GCGCCTGTTACCCCGCTCGAGTACAAAATTTTGCGGTTCAACC GTAATTTTTTTTTGGTGGGGTTTCAACCCCGCCACTCG
D41	ITS (ITS1)	GGGGACCGGGTTCACTCCAACCCCTGTGACATACCTATACGTT GCCTCGGCGGATCAGCCCGCGCCCCGTAAAACGGGACGGCCC GCCCGAGGACCCCTAAACTCTGTTTTTAGTGGAACTTCTGAGT AAAACAAACAAATAAATCAAAACTTTCAACAACGGATCTCTT GGTTCTGGCATCGATGAAGAACGCAGCAAAATGCGATAAGTA ATGTGAATTGCAGAATTCAGTGAATCATCGAATCTTTGAACGC ACATTGCGCCCGCCAGTATTCTGGCGGGCATGCCTGTTCGAGC GTCATTTCAACCCTCAAGCTCAGCTTGGTGTTGGGACTCGCGG TAACCCGCGTTCCCCAAATCGATTGGCGGTCACGTCGAGCTTC CATAGCGTAGTAATCATACACCTCGTTACTGGTAATCGTCGCG GCCACGCCGTAAAACCCCAACTTCTGAATGTTGACCTCGGATC AGGTAGGAATACCCGCTGAACTTAAGCATATCAATAAGGCGG AGTAAT
D44	TEF (EF1)	CGACCACTGTGAGTACTCTCCTCAACAATGAGCTTATCTGCCA TCGTCAATCCCGACCAAGACCTGGTGGGGTATTTCTCAAAGTC AACATACTGACATCGTTTCACAGACCGGTCACTTGATCTACCA GTGCGGTGGTATCGACAAGCGAACCATCGAGAAGTTCGAGAA GGTTAGTCACTTTCCCTTCGATCGCGCGTCCTTTGCCCATCGAT TTCCCCTACGACTCGAAACGTACCCGCTACCCCGCTCGAGACC AAAAATTTTGCAATATGACCGTAATTTTTTTGGTGGGGCACTT

		ACCCCGCCACTTGAGCGACGGGAGCGTTTGCCCTCTTAACCAT TCTCACAACCTCAATGAGTGTGTCGTCACGTGTCAAGCAGTCA CTAACCATTCAACAATAGGAAGCCGCTGAGCTCGGTAAGGGTT CCTTCAAGTACGCCTGGGTTCTTGACAAGCTCAAGGCCGAGCG TGAGCGTGGTATCACCATCGATATTGCTCTCTGGAAGTTCGAG ACTCCTCGCTACTATGTCACCGTCATTGGTATGTTGTCGCTCAT GCTTCATTCTACTTCTCTTCGTACTAACATATCACTCAGACGCT CCCGGTCACCGTGATTTCATCAAGAACATGATCACTG
D44	ITS (ITS1)	GGGGAATCGGGCTCACTCCAAACCCCTGTGACATACCTATACG TTGCCTCGGCGGATCAGCCCGCGCCCTGTAAAAAGGGACGGC CCGCCCGAGGACCCTAAACTCTGTTTTAGTGGAACTTCTGAG TAAAACAAACAAATAAATCAAAACTTTCAACAACGGATCTCTT GGTTCTGGCATCGATGAAGAACGCAGCAAAATGCGATAAGTA ATGTGAATTGCAGAATTCAGTGAATCATCGAATCTTTGAACGC ACATTGCGCCCGCCAGTATTCTGGCGGGCATGCCTGTTCGAGC GTCATTTCAACCCTCAAGCTCAGCTTGGTGTTGGGACTCGCGG TAACCCGCGTTCCCCAAATCGATTGGCGGTCACGTCGAGCTTC CATAGCGTAGTAATCATACACCTCGTTACTGGTAATCGTCGCG GCCACGCCGTAAAACCCCAACTTCTGAATGTTGACCTCGGATC AGGTAGGAATACCCGCTGAACTTAAGCATATCAATAGGCGGA GGAAATC
D46	ß- TUBUL IN (BT2)	GTGGGCTCTCTGGCGAGCCGGCCTCGACAGCATGGTGTCTACA ACGGTACCTCCGAGCTCCAGCTCGAGCGCATGAGTGTCTACTT CAACGAGGTATGCCTTAACAGTCAATGCCAACGATCCACAAG CTCACACAACTAGGCCTCTGGCAACAAGTATGTTCCCCGAGCC GTCCTCGTCGATCTTGAGCCTGGTACCATGGACGCTGTCCGTG CTGGTCCCTTCGGTCAGCTCTTCCGTCCCGACAACTTCGTTTTC GGTCAGTCCGGTGCTGGAAACAACTGGGCCAAGGGTCAATAC ACTGAGGGTA
D46	TEF (EF1)	GACTCTGGCAGTCGACCACTGTGAGTACTACCCTGGACGATGA GCTTATCTGCCATCGTGATCCTGACCAAGATCTGGCGGGGTAC ATCTTGGAAGACAATATGCTGACATCGCTTCACAGACCGGTCA CTTGATCTACCAGTGCGGTGGTATCGACAAGCGAACCATCGAG

		AAGTTCGAGAAGGTTAGTCACTTTCCCTTCGATCGCGCGTCCT CTGCCCACCGATTTCACTTGCGATTCGAAACGTGCCTGCTACC CCGCTCGAGACCAAAAATTTTGCGATATGACCGTAATTTTTTT GGTGGGGCATTCACCCCGCCACTCGAGCGATGGGCGCGTTTTT GCCCTCTCCTGTCCACAACCTCAATGAGCGCATTGTCACGTGT CAAGCAGCGACTAACCATTCGACAATAGGAAGCCGCTGAGCT CGGTAAGGGTTCCTTCAAGTACGCCTGGGTTCTTGACAAGCTC AAGGCCGAGCGTGAGCGTGGTATCACCATCGATATTGCTCTCT GGAAGTTCGAGACTCCTCGCTACTATGTCACCGTCATTGGTAT GTTGTCGCTCATACCTCATCCTACTTCCTCATACTAACACATCA TTCAGACGCTCCCGGTCACCGTGATTTCATCAAGAAACATGAT CACTGGGTACTTCCCAA
D46	ITS (ITS1)	GTGGACGGAGTTAACTCCCAACCCCTGTGACATACCTTTGTTG CCTCCGCGGAACAACCCGCTCCCGGTAAAACGGGACGGGCCG CCCGAAGACCCCTAAACTCTGTTTTATATGTAACTTCTGAGTA AAACCATAAATAAATCAAAACTTTCAACAACGGAACTTTTGGT TCTGGGATCCATGAAAAACGCAGCCAAATGGGATTAGTAATG GGAATTGGAGAATTCCATGGATCCTCCGATCTTTGAACGCACA TTGGGCCCGCCCGTATTCTGGGGGGGATGGCTGGTCCAACGTC CTTTCCACCCTCAAGCCCCCGGTTTTGGTGGTGGGGATCGGCA ACCCCTTTCCCCCAACCGGCCCCGAAATCTAGTGGAGGTCCCG CTGCGACTTCCATTGCGTAGTAGTTAAAGCCTCCAACTGGGCC CCGGCGCGGCCCCCCGTTCACCCCGTACTTCTGAATGTTGACC TCAGATCAGGTTGGAATACCCGCTGACTAAGCGTATGAATAGC GGAAGAA
D47	ITS (ITS1)	GGGGGGCTCGGAGATCACTCCAACCCCTGTGACATACCAATTG TTGCCTCGGCGGATCAGCCCGCTCCCGGTAAAACGGGACGGCC CGCCAGAGGACCCCTAAACTCTGTTTCTATATGTAACTTCTGA GTAAAACCATAAATAAATCAAAACTTTCAACAACGGATCTCTT GGTTCTGGCATCGATGAAGAACGCAGCAAAATGCGATAAGTA ATGTGAATTGCAGAATTCAGTGAATCATCGAATCTTTGAACGC ACATTGCGCCCGCCAGTATTCTGGCGGGCATGCCTGTTCGAGC GTCATTTCAACCCTCAAGCCCAGCTTGGTGTTGGGACTCGCGA

		GTCAAATCGCGTTCCCCAAATTGATTGGCGGTCACGTCGAGCT TCCATAGCGTAGTAGTAAAACCCTCGTTACTGGTAATCGTCGC GGCCACGCCGTTAAACCCCAACTTCTGAATGTTGACCTCGGAT CAGGTAGGAATACCCGCTGAACTTAAGAATATCAATAAGGCG GGAGGA
D48	ITS (ITS1)	GGGGGTTCGGAATTTCGCTCTGCACCTTTGTGACATACCTATA ACTGTTGCTTCGGCGGGTAGGGTCCCCGTGACCCTCCCGGCCC CCCGCCCCCGGGCGGGTCGGCGCCCGCCGGAGGATAACCAAA CTCTGATTTAACGACGTTTCTTCTGAGTGGTACAAGCAAATAA TCAAAACTTTTAACAACGGATCTCTTGGTTCTGGCATCGATGA AGAACGCAGCGAAATGCGATAAGTAATGTGAATTGCAGAATT CAGTGAATCATCGAATCTTTGAACGCACATTGCGCCCGCCAGC ATTCTGGCGGGCATGCCTGTTCGAGCGTCATTTCAACCCTCAA GCTCTGCTTGGTGTTGGGGCCCTACAGCAGATGTAGGCCCTCA AAGGTAGTGGCGGACCCTCCCGGAGCCTCCTTTGCGTAGTAAC TTTACGTCTCGCACTGGGATCCGGAGGGACTCTTGCCGTAAAA CCCCCCAATTTTCCAAAGGTTGACCTCGGATCAGGTAGGAATA CCCGCTGAACTTAAGCATATCAATAGGCGGAGGAA
D50	ITS (ITS1)	GTGGCATGCCGGGAGCGCCAGGCGCACCCAGAAACCCTTTGT GAACTTATACCTTTTGTTGCCTCGGCGCTGCTGGGCCTTTATAA GGCCCCCCCTTCCGGGAAGAAAACGGCACCCCGCCGGCCAAT TTAATTCGGTTTTTACCCGGAACCCCTAAAAAAAACCCCAATG GATCCAAACTTTTCACCACCGAACCCTTGGTTCCGGGCTCCAT TAAAAAACCCACCAAATGGCAATAATTAAGGGGAATGGCAAA ATTCGTGGATCCTCCAAACCTTTAACCCCCCTTGGCCCCTCCGG GATTTCCGAAGGGATGGCTGGTTCAACCTTCTTTTCACCCCCC AGCCTTGGTTGGTGGTGGGGCCCCGGCTTTAACCAAACCAGGC CCGGAATCCAATGGCCAAGTTCCCCAGGACCCCAACCGAATA ATTTAACCCTTCCTTTTGAAAGGCCTGGGCGTGGCCTGGCCTTT AACCCCCCACTTTTTAAAAATTTAACCCCGAATCAGGTAGAAT TACCCCCTAACTTTAACCTAATCATTAACGGAAGAAA
D51	ß-TUBUL	TAGTCTCTCTGGCGAGCCGGTCTCGACAGCAATGGTGTTTACA ACGGTACCTCCGAGCTCCAGCTCGAGCGTATGAGCGTCTACTT

	IN (BT2)	CAACGAGGTTTGTTTCATCACTCCTGCCACGAAAACACAACAAGCTCACGCGCGCCTAGGCTTCCGGTAACAAGTATGTTCCCCGTGCCGTCCTCGTCGATCTCGAGCCCGGTACCATGGACGCCGTCCGTGCCGGTCCTTTCGGACAGCTTTTCCGTCCCGACAACTTCGTTTTCGGTCAATCCGGTGCCGGAAACAACTGGGCCAAGGGTCACTACACTGAGGGTA
D51	TEF (EF1)	CCAGTGCGGTGGTATCGACAAGCGAACCATCGAGAAGTTCGAGAAGGTTGGTTTCCATTTCCCCGATCGCACGCCGTCTACCCACCGATCCATCAGT
D51	ITS (ITS1)	GGGGGCTCGACTTCACTCCAACCCCTGTGACATACCTATACGTTGCCTCGGCGGATCAGCCCGCGCCCCGTAAAACGGGACGGCCCGCCCGAGGACCCCTAAACTCTGTTTTTAGTGGAACTTCTGAGTAAAACAAACAAATAAATCAAAACTTTCAACAACGGATCTCTTGGTTCTGGCATCGATGAAGAACGCAGCAAAATGCGATAAGTAATGTGAATTGCAGAATTCAGTGAATCATCGAATCTTTGAACGCACATTGCGCCCGCCAGTATTCTGGCGGGCATGCCTGTTCGAGCGTCATTTCAACCCTCAAGCTCAGCTTGGTGTTGGGACTCGCGGTAACCCGCGTTCCCCAAATCGATTGGCGGTCACGTCGAGCTTCCATAGCGTAGTAATCATACACCTCGTTACTGGTAATCGTCGCGGCCACGCCGTAAAACCCCAACTTCTGAATGTTGACCTCGGATCAGGTAGGAATACCCGCTGAACTTAAGCATATCAATAAGGCGGAGGAAAC
D52	ß-TUBULIN (BT1)	AGGGGTCTGACATGAAGCCGCGGCGCTCACTCTTTCCGCGCTGTCAGCGTTCCCGAGCTTACCCAGCAGATGTTCGACCCCAAGAACATGATGGCCGCTTCTGACTTCCGCAACGGTCGCTACCTGACCTGCTCTGCCATCTTGTAAGTTCTGTTCTCTCCATGCCGAGCAATCGCTAACATTTCCCAGCCGCGGCCGTGTCACCATGAAGGAGGTCGAGGACGAAATGCGCAACGTCCAGAACAAGAACTCGTCCTACTTCGTCGAGTGGATCCCCAACAACATCCAGACTGCTCTCTGCACCATCCCCCCTCGTGGCCTTACCATGTCCTCCACCTTTATTGGAAACTCCACCTCCATCCAGGAGCTCTTCAAGCGTATCGGCGAGCAGTTCACTGCCATGTTCCAACGCAAGGCTTTCCTTCACTGGTACACTGGTGAGGGTATGGACAAGATGGAGTTCACTGAGGCTG

		AGTTCAACATGAACGATCTCATC
D52	ITS (ITS1)	GGGGCTCGAGTTACACTCATCAACCCTGTGAACATACCTAAAACGTTGCTTCGGCGGGAACAGACGGCCCCGTAACACGGGCCGCCCCCGCCAGAGGACCCCTAACTCTGTTTATATTATGTTTTTCTGAGTAAACAAGCAAATAAATTAAAACTTTCAACAACGGATCTCTTGGCTCTGGCATCGATGAAGAACGCAGCGAAATGCGATAAGTAATGTGAATTGCAGAATTCAGTGAATCATCGAATCTTTGAACGCACATTGCGCCCGCCAGTATTCTGGCGGGCATGCCTGTTCGAGCGTCATTACAACCCTCAGGCCCCCGGGCCTGGCGTTGGGGATCGGCGGAAAGCCCCCTGTGGGCATACGCCGTCCCCTAAATACAGTGGCGGTCCCGCCGCAGCTTCCATTGCGTAGTAGCTAACACCTCGCAACTGGAGAGCGGCGCGGCCAAGCCGTAAAACCCCCAACTTCTGAATGTTGACCTCGAATCAGGTAGGAATACCCGCTGAACTTAAGCATATCAATAAGGCGGAGGA
D53	ß-TUBULIN (BT2)	GGTCCCTCTTCTGGCGAGCACGGCCTCGACAGCAATGGTGTCTACAACGGTACCTCCGAGCTTCAGCTCGAGCGCATGAGTGTTTATTTCAACGAGGTATGCATTAGCAGTCAATGTCAAGAGTTCCCAAGCTCACACATCTAGGCCTCTGGCAACAAGTATGTTCCCCGAGCCGTCCTCGTCGATCTCGAGCCCGGTACCATGGACGCCGTCCGTGCTGGTCCCTTCGGTCAGCTCTTCCGTCCTGACAACTTCGTTTTTGGTCAGTCCGGTGCTGGAAACAACTGGGCCAAGGGTCAATACACTGAGGGTA
D53	TEF (EF1)	CTCTGGCAGTCGGACCACTGTGAGTACTACCCTCGACGATGAGCTTATCTGCCATCGTAATCCCGACTAAAACCTGGCGGGGTATTTCTCAAAAGCCAACATGCTGACATCACTTCACAGACCGGTCACTTGATCTACCAGTGCGGTGGTATCGACAAGCGAACCATCGAGAAGTTCGAGAAGGTTAGTCACTTTCCCTTCGATCGCGCGTCCTTTGTCCATCGATTTCCCCTACGACTCGAAACGTGCCCGCTACCCCGCTCGAGTCCAAAAATTTTGCGATATGACCGTAATTTTTTTGGTGGGGCATTTACCCCGCCACTCGAGCGGCGCGTTTTTGCCCTCTCCCATTCCACAACCTCACTGAGCGCATCGTCACGTGTCAAGCAGTCACTAACAGTTCGACAATAGGAAGCCGCTGAGCTCGGTAAGGGTTCCTTCAAGTACGCCTGGGTTCTTGACAAGCTCAAGGCC

		GAGCGTGAGCGTGGTATCACCATCGATATTGCTCTCTGGAAGT TCGAGACTCCTCGCTACTATGTCACCGTCATTGGTATGTTGTCG CTCATGCGCCGTTCTACATCTCTTACTAACATGACACTCAGAC GCTCCCGGTCACCGTGATTTCATCAAGAACATGATCACTGGGT ACTTCCC
D53	ITS (ITS1)	TGGGGGGTCGGGTTTCACTCATCACCCTGTGACATACCTAAAC GTTGCTTCGGCGGGAATAGACGGCCCCGTGAAACGGGCCGCC CCCGCCAGAGGACCCTTAACTCTGTTTCTATAATGTTTCTTCTG AGTAAAACAAGCAAATAAATTAAAACTTTCAACAACGGATCT CTTGGCTCTGGCATCGATGAAGAACGCAGCGAAATGCGATAA GTAATGTGAATTGCAGAATTCAGTGAATCATCGAATCTTTGAA CGCACATTGCGCCCGCCAGTATTCTGGCGGGCATGCCTGTTCG AGCGTCATTACAACCCTCAGGCCCCCGGGCCTGGCGTTGGGGA TCGGCGGAGCCCTTTGTGGGCACACGCCGTCCCCCAAATACAG TGGCGGTCCCGCCGCAGCTTCCATCGCGTAGTAGCTAACACCT CGCGACTGGAGAGCGGCGCGGCCACGCCGTAAAACACCCAAC TCTTCTGAAGTTGACCTCGAATCAGGTAGGAATACCCGCTGAA CTTAAGCATATCAATAAGCGGAGGAAT
D56	ß-TUBULIN (BT1)	AGGCTTCTCCTCATGACAGCCGCGGCGCCCACTCTTTCCGCGC TGTCAGCGTTCCCGAGCTTACCCAGCAGATGTTTGACCCCAAG AACATGATGGCTGCTTCTGACTTCCGCAACGGTCGCTACCTGA CCTGCTCTGCCATCTTGTAAGTTTTGTCCTCTCCATGTCGAGTA ATCGCTAACATTTCCTAGCCGTGGCCGTGTCGCCATGAAGGAG GTCGAGGACCAGATGCGCAACGTCCAGAACAAGAACTCGTCC TACTTCGTCGAGTGGATCCCCAACAACATCCAGACTGCTCTCT GCGCCATCCCCCCTCGTGGCCTTACCATGTCCTCCACCTTTATC GGAAACTCCACCTCCATCCAGGAGCTCTTCAAGCGTATCGGCG AGCAGTTCACTGCCATGTTCCGACGCAAGGCTTTCCTTCACTG GTACACTGGTGAGGGTATGGACGAGATGGAGTTCACTGAGGC TGAGTTCAACATGAACGATCTCGTC
D56	ITS (ITS1)	GGGGATTCGGAAGTTCACTCATCACCCTGTGACATACCTAAAA CGTTGCTTCGGCGGGAACAGACGGCCCCGTAACACGGGCCGC CCCCGCCAGAGGACCCCCTAACTCTGTTTCTATTATGTTTCTTC

		TGAGTAAAACAAGCAAATAAATTAAAACTTTCAACAACGGAT CTCTTGGCTCTGGCATCGATGAAGAACGCAGCGAAATGCGATA AGTAATGTGAATTGCAGAATTCAGTGAATCATCGAATCTTTGA ACGCACATTGCGCCCGCCAGTATTCTGGCGGGCATGCCTGTTC GAGCGTCATTACAACCCTCAGGCCCCCGGGCCTGGCGTTGGGG ATCGGCGAGGCGCCCCCTGCGGGCACACGCCGTCCCCCAAAT ACAGTGGCGGTCCCGCCGCAGCTTCCATTGCGTAGTAGCTAAC ACCTCGCAACTGGAGAGCGGCGCGGCCACGCCGTAAAACACC CAACTTCTGAATGTTGACCTCGAATCAGGTAGGAATACCCGCT GAACTTAAGCATATCAATAGGCCGGAGGAA
D58	ß-TUBULIN (BT2)	ATTACCTCCTCTGGCGAGCCGGTCTCGACAGCAATGGTGTTTA CAACGGTACCTCCGAGCTCCAGCTCGAGCGCATGAGCGTCTAC TTCAACGAGGTTTGTTCCATCACTCCTACCACGAAAACACAAC AAGCTCACGCGCGCCTAGGCTTCCGGTAACAAGTATGTTCCCC GTGCCGTCCTTGTCGATCTCGAGCCCGGTACCATGGACGCCGT CCGTGCCGGTCCTTTCGGACAGCTTTTCCGCCCCGACAACTTC GTTTTCGGTCAGTCCGGTGCCGGAAACAACTGGGCCAAGGGTC ACTACACTGAGGGTA
D58	ITS (ITS1)	GGGGGATGAGGTTCACTCCAACCCCTGTGACATACCTATACGT TGCCTCGGCGGATCAGCCCGCGCCCTGTAAAACGGGACGGCC CGCCCGAGGACCCCTAAACTCTGTTTTTAGTGGAACTTCTGAG TAAAACAAACAAATAAATCAAAACTTTCAACAACGGATCTCTT GGTTCTGGCATCGATGAAGAACGCAGCAAAATGCGATAAGTA ATGTGAATTGCAGAATTCAGTGAATCATCGAATCTTTGAACGC ACATTGCGCCCGCCAGTATTCTGGCGGGCATGCCTGTTCGAGC GTCATTTCAACCCTCAAGCTCAGCTTGGTGTTGGGACTCGCGG TAACCCGCGTTCCCCAAATCGATTGGCGGTCACGTCGAGCTTC CATAGCGTAGTAATCATACACCTCGTTACTGGTAATCGTCGCG GCCACGCCGTAAAACCCCAACTTCTGAATGTTGACCTCGGATC AGGTAGGAATACCCGCTGAACTTAAGCATATCAATAGGCCGG AGGAAT
D60	ß-TUBUL	GCTTACTCTCTGGGCGAGCCGGTCTCGACAGCATGGTGTTTAC AACGGTACCTCCGAGCTCCAGCTCGAGCGTATGAGCGTCTACT

	IN (BT2)	TCAACGAGGTTTGTTTTATCTCTCCTGCCACGAAAACACAACA AGCTCACGCGCGCCTAGGCTTCCGGTAACAAGTATGTTCCCCG TGCCGTCCTCGTCGATCTCGAGCCCGGTACCATGGACGCTGTC CGTGCCGGTCCTTTCGGACAGCTTTTCCGTCCCGACAACTTCGT TTTCGGTCAATCCGGTGCCGGAAACAACTGGGCCAAGGGTCAC TACACTGAGGGTA
D60	ITS (ITS1)	GGGGCTTCGGGATACTCCAAACCCCTGTGACATACCTATACGT TGCCTCGGCGGATCAGCCCGCGCCCTGTAAAACGGGACGGCC CGCCCGAGGACCCTAAACTCTGTTTTTAGTGGAACTTCTGAGT AAAACAAACAAATAAATCAAAACTTTCAACAACGGATCTCTT GGTTCTGGCATCGATGAAGAACGCAGCAAAATGCGATAAGTA ATGTGAATTGCAGAATTCAGTGAATCATCGAATCTTTGAACGC ACATTGCGCCCGCCAGTATTCTGGCGGGCATGCCTGTTCGAGC GTCATTTCAACCCTCAAGCTCAGCTTGGTGTTGGGACTCGCGG TAACCCGCGTTCCCCAAATCGATTGGCGGTCACGTCGAGCTTC CATAGCGTAGTAATCATACACCTCGTTACTGGTAATCGTCGCG GCCACGCCGTAAAACCCCAACTTCTGAATGTTGACCTCGGATC AGGTAGGAATACCCGCTGAACTTAAGCATATCAATAGGCAGA GGACTA
D66	ITS (ITS1)	GGGGGATCGGACTTTCGAGCTCGGCTCGACTCTCCCACCCTTT GTGAACGTACCTCTGTTGCTTTGGCGGCTCCGGCCGCCAAAGG ACCTTCAAACTCCAGTCAGTAAACGCAGACGTCTGATAAACAA GTTAATAAACTAAAACTTTCAACAACGGATCTCTTGGTTCTGG CATCGATGAAGAACGCAGCGAAATGCGATAAGTAATGTGAAT TGCAGAATTCAGTGAATCATCGAATCTTTGAACGCACATTGCG CCCCTTGGTATTCCGGGGGGCATGCCTGTTCGAGCGTCATTAC AACCCTCAAGCTCTGCTTGGAATTGGGCACCGTCCTCACTGCG GACGCGCCTCAAAGACCTCGGCGGTGGCTGTTCAGCCCTCAAG CGTAGTAGAATACACCTCGCTTTGGAGCGGTTGGCGTCGCCCG CCGGACGAACCTTCTGAACTTTTCTCAAGGTTGACCTCGGATC AGGTAGGGATACCCGCTGAACTTAAGCATATCAATACGAATTA GGAA

D66	ß-TUBULIN (BT2)	GATTTGGTTGCAAACCTCCTGCTCCTGCGCCCCCGCTGACGGAAGCGACACCATAGGCAGACCATCTCCGGCGAGCACGGCCTGGATGGCTCCGGTGTGTAAGTGTGCGCCTTCTCCGCCGCGCATCGCAATCGCTGACCCGTAGCAGCTACAATGGCACCTCGGACCTCCAACTGGAGCGCATGAACGTCTACTTCAACGAGGTACTCTCTCCATAATTAGACAAACACGTAAAGTATGGCAATCTTCTGAACGCGCAGCAGGCGTCCAACAACAAGTACGTTCCTCGTGCTGTCCTCGTCGACCTCGAGCCCGGCACCATGGATGCCGTCCGCGCCGGCCCCTTCGGTCAGCTCTTCCGCCCCGACAACTTCGTCTTCGGCCAGTCTGGTGCCGGTAACAACTGGGCCGATACTAACTACACTGAGGGTA
D67	ß-TUBULIN (BT1)	AAAGGGGTCTCTTCCCTCACAGCTGTGCTGCTCACTCTTTCCGCGCTGTCAGCGTTCCTGAGCTGACCCAGCAGATGTTCGACCCCAAGAACATGATGGCTGCTTCCGACTTCCGCAACGGTCGTTACCTGACCTGCTCTGCCATCTTCCGTGGCCGCGTCGCCATGAAGGAGGTCGAGGACCAGATGCGCAACGTTCAGAACAAGAACTCATCTTACTTCGTCGAGTGGATTCCTAACAACATCCAGACCGCTCTCTGCGCTATTCCTCCTCGGGGACTTACTATGTCCTCTACCTTTATTGGAAACTCCACCTCTATCGAGGAGCTTTTCTTGCGTGGTGGAGAGCAGTTTACTGCTATGTGCAGACGCAAGGCTTTAAAGCATTGGTACACTGGTGAGGGGGGGGACCACCCCCCCTTTCACTGAGGGGGGGGTTCAAACAAAAAA
D67	ITS (ITS1)	GGGGATATCGGAGTTCACTCCAAACCCCTGTGACATACCTATACGTTGCCTCGGCGGATCAGCCCGCGCCCCGTAAAAAGGGACGGCCCGCCCGAGGACCCCTAAACTCTGTTTTAGTGGAACTTCTGAGTAAAACAAACAAATAAATCAAAACTTTCAACAACGGATCTCTTGGTTCTGGCATCGATGAAGAACGCAGCAAAATGCGATAAGTAATGTGAATTGCAGAATTCAGTGAATCATCGAATCTTTGAACGCACATTGCGCCCGCCAGTATTCTGGCGGGCATGCCTGTTCGAGCGTCATTTCAACCCTCAAGCTCAGCTTGGTGTTGGGACTCGCGGTAACCCGCGTTCCCCAAATCGATTGGCGGTCACGTCGAGCTTCCATAGCGTAGTAATCATACACCTCGTTACTGGTAATCGTCGCGGCCACGCCGTAAAACCCCAACTTCTGAATGTTGACCTCGG

		ATCAGGTAGGAATACCCGCTGAACTTAAGCATATCAATAGGC GGAGGAATCA
D71	TEF (EF1)	GAATATTTGCTGACAAGATTGCATAGACCGGTCACTTGATCTA CCAGTGCGGTGGTATCGACAAGCGAACCATCGAGAAGTTCGA GAAGGTTGGTTTCCATTTCCCCGATCGCACGCCGTCTACCCAC CGATCCATCAGTCGAATCAGTTACGACGATTGAATATGCGCCT GTTACCCCGCTCGAGTACAAAATTTTGCGGTTCAACCGTAATT TTTTTGGTGGGGTTTCAACCCCGCTACTCGAGCGACAGACGTT TGCCCTCTTCCCACAAACTCATGTCTCGTGCATCACGTGTCCAT CAGCCACTAACCACCCGACAATAGGAAGCCGCCGAGCTCGGT AAGGGTTCCTTCAAGTACGCCTGGGTTCTTGACAAGCTCAAGG CTGAGCGTGAGCGTGGTATCACCATCGATATCGCCCTCTGGAA GTTCGAGACTCCTCGCTACTATGTCACCGTCATTGGTACGTTAT CATCACTTACACTCAATACTTTCTCATGCTAACATGTACTTCAG ACGCTCCCGGTCACCGTGATTTCATCAAGAACATGATCACTGG TACTTCCC
D71	ITS (ITS1)	GGGGGGTTCAGGGCTTCACTCCAAACCCCTGTGACATACCTAT ACGTTGCCTCGGCGGATCAGCCCGCGCCCCGTAAAACGGGAC GGCCCGCCCGAGGACCCCTAAACTCTGTTTTTAGTGGAACTTC TGAGTAAAACAAACAAATAAATCAAAACTTTCAACAACGGAT CTCTTGGTTCTGGCATCGATGAAGAACGCAGCAAAATGCGATA AGTAATGTGAATTGCAGAATTCAGTGAATCATCGAATCTTTGA ACGCACATTGCGCCCGCCAGTATTCTGGCGGGCATGCCTGTTC GAGCGTCATTTCAACCCTCAAGCTCAGCTTGGTGTTGGGACTC GCGGTAACCCGCGTTCCCCAAATCGATTGGCGGTCACGTCGAG CTTCCATAGCGTAGTAATCATACACCTCGTTACTGGTAATCGT CGCGGCCACGCCGTAAAACCCCAACTTCTGAATGTTGACCTCG GATCAGGTAGGAATACCCGCTGAACTTAAGCATATCAATAAG CCGGAGGAAT
D73	ITS (ITS1)	GGGGTTCGGGCTTCGAGCTCGGCTCGACTCTCCCACCCTTTGT GAACGTACCTCTGTTGCTTTGGCGGCTCCGGCCGCCAAAGGAC CTTCAAACTCCAGTCAGTAAACGCAGACGTCTGATAAACAAGT TAATAAACTAAAACTTTCAACAACGGATCTCTTGGTTCTGGCA

		TCGATGAAGAACGCAGCGAAATGCGATAAGTAATGTGAATTG CAGAATTCAGTGAATCATCGAATCTTTGAACGCACATTGCGCC CCTTGGTATTCCGGGGGGCATGCCTGTTCGAGCGTCATTACAA CCCTCAAGCTCTGCTTGGAATTGGGCACCGTCCTCACTGCGGA CGCGCCTCAAAGACCTCGGCGGTGGCTGTTCAGCCCTCAAGCG TAGTAGAATACACCTCGCTTTGGAGCGGTTGGCGTCGCCCGCC GGACGAACCTTCTGAACTTTTCTCAAGGTTGACCTCGGATCAG GTAGGGATACCCGCTGAACTTAAGCATATCAATAAGGCGGAT GAAG
D74	ITS (ITS1)	TGGGACCGGACCTTCGAGCTCGGCTCGACTCTCCCACCCTTTG TGAACGTACCTCTGTTGCTTTGGCGGCTCCGGCCGCCAAAGGA CCTTCAAACTCCAGTCAGTAAACGCAGACGTCTGATAAACAAG TTAATAAACTAAAACTTTCAACAACGGATCTCTTGGTTCTGGC ATCGATGAAGAACGCAGCGAAATGCGATAAGTAATGTGAATT GCAGAATTCAGTGAATCATCGAATCTTTGAACGCACATTGCGC CCCTTGGTATTCCGGGGGGCATGCCTGTTCGAGCGTCATTACA ACCCTCAAGCTCTGCTTGGAATTGGGCACCGTCCTCACTGCGG ACGCGCCTCAAAGACCTCGGCGGTGGCTGTTCAGCCCTCAAGC GTAGTAGAATACACCTCGCTTTGGAGCGGTTGGCGTCGCCCGC CGGACGAACCTTCTGAACTTTTCTCAAGGTTGACCTCGGATCA GGTAGGGATACCCGCTGAACTTAAGCATATCAATAAGACGGA GGAA
D74	ß-TUBULIN (BT2)	GGGTTGTTGCAACCTCCTGCTCTGCGCCCCCGCTGACGGAAGC GACACCATAGGCAGACCATCTCCGGCGAGCACGGCCTGGATG GCTCCGGTGTGTAAGTGTGCGCCTTCTCCGCCGCGCATGGCAA TCGCTGACCTGTAGCAGCTACAATGGCACTTCGGACCTCCAAC TGGAGCGCATGAACGTCTACTTCAACGAGGTACTCTCTCCATA ATTAGACAAACACGTAAAGTATGGCAATCTTCTGAACGCGCA GCAGGCGTCCAACAACAAGTACGTTCCTCGTGCTGTCCTCGTC GACCTCGAGCCCGGCACCATGGATGCCGTCCGCGCCGGCCCCT TCGGCCAGCTCTTCCGCCCCGACAACTTCGTCTTCGGCCAGTCT GGTGCCGGTAACAACTGGGCCAGAATGTACCTACACTGAGGG TA

D75	ITS (ITS1)	GGGGCTACGAGCTTTCGGGCTTCGGCTCGACTCTCCCACCCTT TGTGAACGTACCTCTGTTGCTTTGGCGGCTCCGGCCGCCAAAG GACCTCCAAACTCCAGTCAGTAAACGCAGACGTCTGATAAAC AAGTTAATAAACTAAAACTTTCAACAACGGATCTCTTGGTTCT GGCATCGATGAAGAACGCAGCGAAATGCGATAAGTAATGTGA ATTGCAGAATTCAGTGAATCATCGAATCTTTGAACGCACATTG CGCCCCTTGGTATTCCGGGGGGCATGCCTGTTCGAGCGTCATT ACAACCCTCAAGCTCTGCTTGGAATTGGGCACCGTCCTCACTG CGGACGCGCCTCAAAGACCTCGGCGGTGGCTGTTCAGCCCTCA AGCGTAGTAGAATACACCTCGCTTTGGAGTGGTTGGCGTCGCC CGCCGGACGAACCTTCTGAACTTTTCTCAAGGTTGACCTCGGA TCAGGTAGGGATACCCGCTGAACTTAAGCATATCAATAAGATT TACAAG
D75	ß-TUBULIN (BT2)	GAGTAGTTTCAAACACTCCTGCTCTGCGCCCCCGCTGACGGAA GCGACACCATAGGCAGACCATCTCTGGCGAGCACGGCCTGGA TGGCTCCGGTGTGTAAGTGTGCGCCTTCTCCGCCGCGCATGGC AATCGCTGACCCGTAGCAGCTACAATGGCACCTCGGACCTCCA ACTGGAGCGCATGAACGTCTACTTCAACGAGGTACTCTCTCCA TAATTAGACAAACACGTAAAGTATGGCAATCTTCTGAACGCGC AGCAGGCGTCCAACAACAAGTACGTTCCTCGTGCTGTCCTCGT CGACCTCGAGCCCGGCACCATGGATGCCGTCCGCGCCGGCCCC TTCGGCCAGCTCTTCCGCCCCGACAACTTCGTCTTCGGCCAGTC TGGTGCCGGTAACAACTGGGCCAAGAGTCTCAACACTGAGGG TA
D76	ITS (ITS1)	GGGGGATCGGGCTCGGGCTTCGGCTCGACTCTCCCACCCTTTG TGACGTACCTCTGTTGCTTTGGCGGCTCCGGCCGCCAAAGGAC CTCCAAACTCCAGTCAGTAAACGCAGACGTCTGATAAACAAGT TAATAAACTAAAACTTTCAACAACGGATCTCTTGGTTCTGGCA TCGATGAAGAACGCAGCGAAATGCGATAAGTAATGTGAATTG CAGAATTCAGTGAATCATCGAATCTTTGAACGCACATTGCGCC CCTTGGTATTCCGGGGGGCATGCCTGTTCGAGCGTCATTACAA CCCTCAAGCTCTGCTTGGAATTGGGCACCGTCCTCACTGCGGA CGCGCCTCAAAGACCTCGGCGGTGGCTGTTCAGCCCTCAAGCG

		TAGTAGAATACACCTCGCTTTGGAGTGGTTGGCGTCGCCCGCCGGACGAACCTTCTGAACTTTTCTCAAGGTTGACCTCGGATCAGGTAGGGATACCCGCTGAACTTAAGCATATCAATAAGTGGAGGAA
D76	ß-TUBULIN (BT2)	AGGGTGTGGGGCAAACTCCTGCTCTGCGCCCCCCGCTGACGGAAGCGACACCATAGGCAGACCATCTCTGGCGAGCACGGCCTGGATGGCTCCGGTGTGTAAGTGTGCGCCTTCTCCGCCGCGCATGGCAATCGCTGACCCGTAGCAGCTACAATGGCACCTCGGACCTCCAACTGGAGCGCATGAACGTCTACTTCAACGAGGTACTCTCTCCATAATTAGACAAACACGTAAAGTATGGCAATCTTCTGAACGCGCAGCAGGCGTCCAACAACAAGTACGTTCCTCGTGCTGTCCTCGTCGACCTCGAGCCCGGCACCATGGATGCCGTCCGCGCCGGCCCCTTCGGCCAGCTCTTCCGCCCCGACAACTTCGTCTTCGGCCAGTCTGGTGCCGGTAACAACTGGGCCAAAAACTCTCTAAACTGAGGGTA
D77	ITS (ITS1)	GGGGCAACGGACTTTCGAGCTCGGCTCGACTCTCCCACCCTTTGTGAACGTACCTCTGTTGCTTTGGCGGCTCCGGCCGCCAAAGGACCTTCAAACTCCAGTCAGTAAACGCAGACGTCTGATAAACAAGTTAATAAACTAAAACTTTCAACAACGGATCTCTTGGTTCTGGCATCGATGAAGAACGCAGCGAAATGCGATAAGTAATGTGAATTGCAGAATTCAGTGAATCATCGAATCTTTGAACGCACATTGCGCCCCTTGGTATTCCGGGGGGCATGCCTGTTCGAGCGTCATTACAACCCTCAAGCTCTGCTTGGAATTGGGCACCGTCCTCACTGCGGACGCGCCTCAAAGACCTCGGCGGTGGCTGTTCAGCCCTCAAGCGTAGTAGAATACACCTCGCTTTGGAGCGGTTGGCGTCGCCCGCCGGACGAACCTTCTGAACTTTTCTCAAGGTTGACCTCGGATCAGGTAGGGATACCCGCTGAACTTAAGCATATCAATAAGTTTGAAAGA
D77	ß-TUBULIN (BT2)	GGTGTGGGGTTCAACCCTCCTGCTCCTGCGCCCCCCGCTGACGGAAGCGACACCATAGGCAGACCATCTCCGGCGAGCACGGCCTGGATGGCTCCGGTGTGTAAGTGTGCGCCTTCTCCGCCGCGCATGGCAATCGCTGACCTGTAGCAGCTACAATGGCACTTCGGACCTCCAACTGGAGCGCATGAACGTCTACTTCAACGAGGTACTCTCT

		CCATAATTAGACAAACACGTAAAGTATGGCAATCTTCTGAACG CGCAGCAGGCGTCCAACAACAAGTACGTTCCTCGTGCTGTCCT CGTCGACCTCGAGCCCGGCACCATGGATGCCGTCCGCGCCGGC CCCTTCGGCCAGCTCTTCCGCCCCGACAACTTCGTCTTCGGCCA GTCTGGTGCCGGTAACAACTGGGCCGAGTGAAACTACACTGA GGGTA
D78	ITS (ITS1)	GGGGAAACGAGTTTCGAGCTCGGCTCGACTCTCCCACCCTTTG TGAACGTACCTCTGTTGCTTTGGCGGCTCCGGCCGCCAAAGGA CCTTCAAACTCCAGTCAGTAAACGCAGACGTCTGATAAACAAG TTAATAAACTAAAACTTTCAACAACGGATCTCTTGGTTCTGGC ATCGATGAAGAACGCAGCGAAATGCGATAAGTAATGTGAATT GCAGAATTCAGTGAATCATCGAATCTTTGAACGCACATTGCGC CCCTTGGTATTCCGGGGGGCATGCCTGTTCGAGCGTCATTACA ACCCTCAAGCTCTGCTTGGAATTGGGCACCGTCCTCACTGCGG ACGCGCCTCAAAGACCTCGGCGGTGGCTGTTCAGCCCTCAAGC GTAGTAGAATACACCTCGCTTTGGAGCGGTTGGCGTCGCCCGC CGGACGAACCTTCTGAACTTTTCTCAAGGTTGACCTCGGATCA GGTAGGGATACCCGCTGAACTTAAGCATATCAATAAGTTTTAG GA
D79	ITS (ITS1)	TGGGGGATTCGGACTTCGAGCTCGGCTCGACTCTCCCACCCTT TGTGAACGTACCTCTGTTGCTTTGGCGGCTCCGGCCGCCAAAG GACCTTCAAACTCCAGTCAGTAAACGCAGACGTCTGATAAACA AGTTAATAAACTAAAACTTTCAACAACGGATCTCTTGGTTCTG GCATCGATGAAGAACGCAGCGAAATGCGATAAGTAATGTGAA TTGCAGAATTCAGTGAATCATCGAATCTTTGAACGCACATTGC GCCCCTTGGTATTCCGGGGGGCATGCCTGTTCGAGCGTCATTA CAACCCTCAAGCTCTGCTTGGAATTGGGCACCGTCCTCACTGC GGACGCGCCTCAAAGACCTCGGCGGTGGCTGTTCAGCCCTCAA GCGTAGTAGAATACACCTCGCTTTGGAGCGGTTGGCGTCGCCC GCCGGACGAACCTTCTGAACTTTTCTCAAGGTTGACCTCGGAT CAGGTAGGGATACCCGCTGAACTTAAGCATATCAATAAGGTG GAGGAA

D80	ITS (ITS1)	GGGGGCTTCGGAACTTCGAGCTCGGCTCGACTCTCCCACCCTT TGTGAACGTACCTCTGTTGCTTTGGCGGCTCCGGCCGCCAAAG GACCTTCAAACTCCAGTCAGTAAACGCAGACGTCTGATAAACA AGTTAATAAACTAAAACTTTCAACAACGGATCTCTTGGTTCTG GCATCGATGAAGAACGCAGCGAAATGCGATAAGTAATGTGAA TTGCAGAATTCAGTGAATCATCGAATCTTTGAACGCACATTGC GCCCCTTGGTATTCCGGGGGGCATGCCTGTTCGAGCGTCATTA CAACCCTCAAGCTCTGCTTGGAATTGGGCACCGTCCTCACTGC GGACGCGCCTCAAAGACCTCGGCGGTGGCTGTTCAGCCCTCAA GCGTAGTAGAATACACCTCGCTTTGGAGCGGTTGGCGTCGCCC GCCGGACGAACCTTCTGAACTTTTCTCAAGGTTGACCTCGGAT CAGGTAGGGATACCCGCTGAACTTAAGCATATCAATAAACTGT GGA
D80	ß-TUBULIN (BT2)	GGGGGAATGGTCCAAACTACCTGCTCTGCGCCGCCCGGTGACG GAAGCGACACCATAGGAGACCATCTCCGGCGAGCACGGCCTG GATGGCTCCGGTGTGTAAGTGTGCGCCTTCTCCGCCGCGCATG GCAATCGCTGACCTGTAACAGCTACAATGGCACTTCGGACCTC CAACTGGAGCGCATGAACGTCTACTTCAACGAGGTACTCTCTC CATAATTAGACAAACACGTAAAGTATGGCAATCTTCTGAACGC GCAGCAGGCGTCCAACAACAAGTACGTTCCTCGGGCTGTCCTC GTCGACCTCGAGCCCGGCACCATGGATGCCGTCCGCGCCGGCC CCTTCGGCCAGCTCTTCCGCCCCGACAACTTCGTCTTCGGCCA GTCTGGTGCCGGTAACAACTGGGCCAAGGGTAACTACACTGA GGGT
D81	ITS (ITS1)	TGGGGTTTCGGAGTTTCGAGCTCCGGCTCGACTCTCCCACCCTT TGTGAACGTACCTCTGTTGCTTTGGCGGCTCCGGCCGCCAAAG GACCTTCAAACTCCAGTCAGTAAACGCAGACGTCTGATAAACA AGTTAATAAACTAAAACTTTCAACAACGGATCTCTTGGTTCTG GCATCGATGAAGAACGCAGCGAAATGCGATAAGTAATGTGAA TTGCAGAATTCAGTGAATCATCGAATCTTTGAACGCACATTGC GCCCCTTGGTATTCCGGGGGGCATGCCTGTTCGAGCGTCATTA CAACCCTCAAGCTCTGCTTGGAATTGGGCACCGTCCTCACTGC GGACGCGCCTCAAAGACCTCGGCGGTGGCTGTTCAGCCCTCAA

		GCGTAGTAGAATACACCTCGCTTTGGAGCGGTTGGCGTCGCCC GCCGGACGAACCTTCTGAACTTTTCTCAAGGTTGACCTCGGAT CAGGTAGGGATACCCGCTGAACTTAAGCATATCAATAAACGG AGGAG
D82	ITS (ITS1)	GGGGCTAGAGCTACCACTCCCAACCCATGTGAACATATCTCTT TGTTGCCTCGGCGCAAGCTACCCGGGACCTCGCGCCCCGGGCG GCCCGCCGGCGGACAAACCAAACTCTGTTATCTTCGTTGATTA TCTGAGTGTCTTATTTAATAAGTCAAAACTTTCAACAACGGAT CTCTTGGTTCTGGCATCGATGAAGAACGCAGCGAAATGCGATA AGTAATGTGAATTGCAGAATTCAGTGAATCATCGAATCTTTGA ACGCACATTGCGCCCATTAGTATTCTAGTGGGCATGCCTGTTC GAGCGTCATTTCAACCCCTAAGCACAGCTTATTGTTGGGCGTC TACGTCTGTAGTGCCTCAAAGACATTGGCGGAGCGGCAGCAGT CCTCTGAGCGTAGTAATTCTTTATCTCGCTTTTGTTAGGCGCTG CCCCCCCGGCCGTAAAACCCCCCATTTTTCTGGTTGACCTCGG ATCAGGTAGGAATACCCGCTGAACTTAAGCATATCAATAGCG GAGGAAAGGTTTTTCCCCCTTCCAACCCGGGGGGGAATTTTTT TTTTTTTTTGGGGGGAAAGAACCCCGGGAAACCCCGCCCCGC GGGGGGGCGCGGGGGGAAAAAAAAAAAAAGGGGATAACCGT GGGGAACACCAAGGTTTTTTTTTAAAAGATAAAATATTTCCC AAGAAATTTTTTGGGTTTGCGCCCTCCTAAAAAAAACGCCAAG GAGGGGGGGAAGTAGGGGAATAACGGGGAAAAATCGAGAAA TAGAAATTTGAACGCACCTCTCCCTCCTTTGTTGTGTGGGGGC GGCGTCGCCCACACCCACCAGCACACTGGGTGTGGAGGAGCC CCCCCCTACTTCTTAGAAAAAAAGAGGAGGAGGGGGAGGCCC TCTCACATATATAAAAATTTATGACGCTCAAAACACCACGATT GTTGGCGGAGAACGCACACAAGTAAGATAAACCCCCCACTTT AGACCATTCGATAAGCGGGGGAGAAAAAAAAAA
D88	ITS (ITS1)	GGGGCATCGGGGCTTCGGGCTTCGGCTCGACTCTCCCACCCTT TGTGAACGTACCTCTGTTGCTTTGGCGGCTCCGGCCGCCAAAG GACCTCCAAACTCCAGTCAGTAAACGCAGACGTCTGATAAAC AAGTTAATAAACTAAAACTTTCAACAACGGATCTCTTGGTTCT GGCATCGATGAAGAACGCAGCGAAATGCGATAAGTAATGTGA

		ATTGCAGAATTCAGTGAATCATCGAATCTTTGAACGCACATTG CGCCCCTTGGTATTCCGGGGGGCATGCCTGTTCGAGCGTCATT ACAACCCTCAAGCTCTGCTTGGAATTGGGCACCGTCCTCACTG CGGACGCGCCTCAAAGACCTCGGCGGTGGCTGTTCAGCCCTCA AGCGTAGTAGAATACACCTCGCTTTGGAGTGGTTGGCGTCGCC CGCCGGACGAACCTTCTGAACTTTTCTCAAGGTTGACCTCGGA TCAGGTAGGGATACCCGCTGAACTTAAGCATATCAATAAGAC GTAGAGGGG
D89	ITS (ITS1)	GGGGCTTAGAAGATTCGGGCTTCGGCTCGACTCTCCCACCCTT TGTGAACGTACCTCTGTTGCTTTGGCGGCTCCGGCCGCCAAAG GACCTCCAAACTCCAGTCAGTAAACGCAGACGTCTGATAAAC AAGTTAATAAACTAAAACTTTCAACAACGGATCTCTTGGTTCT GGCATCGATGAAGAACGCAGCGAAATGCGATAAGTAATGTGA ATTGCAGAATTCAGTGAATCATCGAATCTTTGAACGCACATTG CGCCCCTTGGTATTCCGGGGGGCATGCCTGTTCGAGCGTCATT ACAACCCTCAAGCTCTGCTTGGAATTGGGCACCGTCCTCACTG CGGACGCGCCTCAAAGACCTCGGCGGTGGCTGTTCAGCCCTCA AGCGTAGTAGAATACACCTCGCTTTGGAGTGGTTGGCGTCGCC CGCCGGACGAACCTTCTGAACTTTTCTCAAGGTTGACCTCGGA TCAGGTAGGGATACCCGCTGAACTTAAGCATATCAATAGGCGT TTTTAAGGTTTCGGGTGACCCTCCACCCCTTTGGAAAGTTACTT TTTTTGCTTTGGGGGTTTCGGCGCCAAGGGC
D89	ß-TUBULIN (BT2)	AGTTGGGGTGGCAACACTCCTGCTCCTGCGCCCCCGCTGACG GAAGCGACACCATAGGCAGACCATCTCTGGCGAGCACGGCCT GGATGGCTCCGGTGTGTAAGTGTGCGCCTTCTCCGCCGCGCAT GGCAATCGCTGACCCGTAGCAGCTACAATGGCACCTCGGACCT CCAACTGGAGCGCATGAACGTCTACTTCAACGAGGTACTCTCT CCATAATTAGACAAACACGTAAAGTATGGCAATCTTCTGAACG CGCAGCAGGCGTCCAACAACAAGTACGTTCCTCGTGCTGTCCT CGTCGACCTCGAGCCCGGCACCATGGATGCCGTCCGCGCCGGC CCCTTCGGCCAGCTCTTCCGCCCCGACAACTTCGTCTTCGGCCA GTCTGGTGCCGGTAACAACTGGGCCGAGGACTACAACACTGA GGGTA

D90	ITS (ITS1)	GGGGCATCGACTTTCGGGCTTCGGCTCGACTCTCCCACCCTTT GTGAACGTACCTCTGTTGCTTTGGCGGCTCCGGCCGCCAAAGG ACCTCCAAACTCCAGTCAGTAAACGCAGACGTCTGATAAACA AGTTAATAAACTAAAACTTTCAACAACGGATCTCTTGGTTCTG GCATCGATGAAGAACGCAGCGAAATGCGATAAGTAATGTGAA TTGCAGAATTCAGTGAATCATCGAATCTTTGAACGCACATTGC GCCCCTTGGTATTCCGGGGGGCATGCCTGTTCGAGCGTCATTA CAACCCTCAAGCTCTGCTTGGAATTGGGCACCGTCCTCACTGC GGACGCGCCTCAAAGACCTCGGCGGTGGCTGTTCAGCCCTCAA GCGTAGTAGAATACACCTCGCTTTGGAGTGGTTGGCGTCGCCC GCCGGACGAACCTTCTGAACTTTTCTCAAGGTTGACCTCGGAT CAGGTAGGGATACCCGCTGAACTTAAGCATATCAATAAGCGG ATGAAG
D90	ß- TUBUL IN (BT2)	GAGGTGTTTTTCCAACCTCCTGCTCTGCGCCCCCCGCTGACGG AAGCGACACCATAGGCAGACCATCTCTGGCGAGCACGGCCTG GATGGCTCCGGTGTGTAAGTGTGCGCCTTCTCCGCCGCGCATG GCAATCGCTGACCCGTAGCAGCTACAATGGCACCTCGGACCTC CAACTGGAGCGCATGAACGTCTACTTCAACGAGGTACTCTCTC CATAATTAGACAAACACGTAAAGTATGGCAATCTTCTGAACGC GCAGCAGGCGTCCAACAACAAGTACGTTCCTCGTGCTGTCCTC GTCGACCTCGAGCCCGGCACCATGGATGCCGTCCGCGCCGGCC CCTTCGGCCAGCTCTTCCGCCCCGACAACTTCGTCTTCGGCCA GTCTGGTGCCGGTAACAACTGGGCCAAGGAATCATACACTGA GGGTA
D91	ITS (ITS1)	GGGATCGGGTTTCGGGCTTCGGCTCGACTCTCCCACCCTTTGT GAACGTACCTCTGTTGCTTTGGCGGCTCCGGCCGCCAAAGGAC CTCCAAACTCCAGTCAGTAAACGCAGACGTCTGATAAACAAGT TAATAAACTAAAACTTTCAACAACGGATCTCTTGGTTCTGGCA TCGATGAAGAACGCAGCGAAATGCGATAAGTAATGTGAATTG CAGAATTCAGTGAATCATCGAATCTTTGAACGCACATTGCGCC CCTTGGTATTCCGGGGGGCATGCCTGTTCGAGCGTCATTACAA CCCTCAAGCTCTGCTTGGAATTGGGCACCGTCCTCACTGCGGA CGCGCCTCAAAGACCTCGGCGGTGGCTGTTCAGCCCTCAAGCG

		TAGTAGAATACACCTCGCTTTGGAGTGGTTGGCGTCGCCCGCC GGACGAACCTTCTGAACTTTTCTCAAGGTTGACCTCGGATCAG GTAGGGATACCCGCTGAACTTAAGCATATCAATAAGTTTTACG AGACTTCGC
D91	ß-TUBULIN (BT2)	AGGTTTTGTTTTAAACCCTCCTGCTCCTGCGCCCCCGCTGACG GAAGCGACACCATAGGCAGACCATCTCTGGCGAGCACGGCCT GGATGGCTCCGGTGTGTAAGTGTGCGCCTTCTCCGCCGCGCAT GGCAATCGCTGACCCGTAGCAGCTACAATGGCACCTCGGACCT CCAACTGGAGCGCATGAACGTCTACTTCAACGAGGTACTCTCT CCATAATTAGACAAACACGTAAAGTATGGCAATCTTCTGAACG CGCAGCAGGCGTCCAACAACAAGTACGTTCCTCGTGCTGTCCT CGTCGACCTCGAGCCCGGCACCATGGATGCCGTCCGCGCCGGC CCCTTCGGCCAGCTCTTCCGCCCCGACAACTTCGTCTTCGGCCA GTCTGGTGCCGGTAACAACTGGGCCAGGAAGTACTTAAACTG AGGGTAA
D94	ITS (ITS1)	GGGATACGGCTTCGAGCTCGGCTCGACTCTCCCACCCTTTGTG AACGTACCTCTGTTGCTTTGGCGGCTCCGGCCGCCAAAGGACC TTCAAACTCCAGTCAGTAAACGCAGACGTCTGATAAACAAGTT AATAAACTAAAACTTTCAACAACGGATCTCTTGGTTCTGGCAT CGATGAAGAACGCAGCGAAATGCGATAAGTAATGTGAATTGC AGAATTCAGTGAATCATCGAATCTTTGAACGCACATTGCGCCC CTTGGTATTCCGGGGGGCATGCCTGTTCGAGCGTCATTACAAC CCTCAAGCTCTGCTTGGAATTGGGCACCGTCCTCACTGCGGAC GCGCCTCAAAGACCTCGGCGGTGGCTGTTCAGCCCTCAAGCGT AGTAGAATACACCTCGCTTTGGAGCGGTTGGCGTCGCCCGCCG GACGAACCTTCTGAACTTTTCTCAAGGTTGACCTCGGATCAGG TAGGGATACCCGCTGAACTTAAGCATATCAATAAGGTTTATGA A
D96	ITS (ITS1)	GGGCCTACGGAGCTGCGAGCTCGGCTCGACTCTCCCACCCTTT GTGAACGTACCTCTGTTGCTTTGGCGGCTCCGGCCGCCAAAGG ACCTTCAAACTCCAGTCAGTAAACGCAGACGTCTGATAAACAA GTTAATAAACTAAAACTTTCAACAACGGATCTCTTGGTTCTGG CATCGATGAAGAACGCAGCGAAATGCGATAAGTAATGTGAAT

		TGCAGAATTCAGTGAATCATCGAATCTTTGAACGCACATTGCG CCCCTTGGTATTCCGGGGGGCATGCCTGTTCGAGCGTCATTAC AACCCTCAAGCTCTGCTTGGAATTGGGCACCGTCCTCACTGCG GACGCGCCTCAAAGACCTCGGCGGTGGCTGTTCAGCCCTCAAG CGTAGTAGAATACACCTCGCTTTGGAGCGGTTGGCGTCGCCCG CCGGACGAACCTTCTGAACTTTTCTCAAGGTTGACCTCGGATC AGGTAGGGATACCCGCTGAACTTAAGCATATCAATAAGGCGT ATGA
D97	ITS (ITS1)	GGGATACGGGCTTTCGAGCTCGGCTCGACTCTCCCACCCTTTG TGAACGTACCTCTGTTGCTTTGGCGGCTCCGGCCGCCAAAGGA CCTTCAAACTCCAGTCAGTAAACGCAGACGTCTGATAAACAAG TTAATAAACTAAAACTTTCAACAACGGATCTCTTGGTTCTGGC ATCGATGAAGAACGCAGCGAAATGCGATAAGTAATGTGAATT GCAGAATTCAGTGAATCATCGAATCTTTGAACGCACATTGCGC CCCTTGGTATTCCGGGGGGCATGCCTGTTCGAGCGTCATTACA ACCCTCAAGCTCTGCTTGGAATTGGGCACCGTCCTCACTGCGG ACGCGCCTCAAAGACCTCGGCGGTGGCTGTTCAGCCCTCAAGC GTAGTAGAATACACCTCGCTTTGGAGCGGTTGGCGTCGCCCGC CGGACGAACCTTCTGAACTTTTCTCAAGGTTGACCTCGGATCA GGTAGGGATACCCGCTGAACTTAAACATATCAATAAGGCGTAT GAAC
D98	ITS (ITS1)	GGGGCTTCGGGCTTTCGAGCTCGGCTCGACTCTCCCACCCTTT GTGAACGTACCTCTGTTGCTTTGGCGGCTCCGGCCGCCAAAGG ACCTTCAAACTCCAGTCAGTAAACGCAGACGTCTGATAAACAA GTTAATAAACTAAAACTTTCAACAACGGATCTCTTGGTTCTGG CATCGATGAAGAACGCAGCGAAATGCGATAAGTAATGTGAAT TGCAGAATTCAGTGAATCATCGAATCTTTGAACGCACATTGCG CCCCTTGGTATTCCGGGGGGCATGCCTGTTCGAGCGTCATTAC AACCCTCAAGCTCTGCTTGGAATTGGGCACCGTCCTCACTGCG GACGCGCCTCAAAGACCTCGGCGGTGGCTGTTCAGCCCTCAAG CGTAGTAGAATACACCTCGCTTTGGAGCGGTTGGCGTCGCCCG CCGGACGAACCTTCTGAACTTTTCTCAAGGTTGACCTCGGATC AGGTAGGGATACCCGCTGAACTTAAGCATATCAATAAGACGG

		AGGA
D99	ITS (ITS1)	GGGGCTTCGGGCTTTCGAGCTCGGCTCGACTCTCCCACCCTTTGTGAACGTACCTCTGTTGCTTTGGCGGCTCCGGCCGCCAAAGGACCTTCAAACTCCAGTCAGTAAACGCAGACGTCTGATAAACAAGTTAATAAACTAAAACTTTCAACAACGGATCTCTTGGTTCTGGCATCGATGAAGAACGCAGCGAAATGCGATAAGTAATGTGAATTGCAGAATTCAGTGAATCATCGAATCTTTGAACGCACATTGCGCCCCTTGGTATTCCGGGGGGCATGCCTGTTCGAGCGTCATTACAACCCTCAAGCTCTGCTTGGAATTGGGCACCGTCCTCACTGCGGACGCGCCTCAAAGACCTCGGCGGTGGCTGTTCAGCCCTCAAGCGTAGTAGAATACACCTCGCTTTGGAGCGGTTGGCGTCGCCCGCCGGACGAACCTTCTGAACTTTTCTCAAGGTTGACCTCGGATCAGGTAGGGATACCCGCTGAACTTAAGCATATCAATAAGACGGAGGAGT
E01	ß-TUBULIN (BT2)	GGTCTCTCTGGCGAGCCGGTCTCGACAGCAATGGTGTTTACAACGGTACCTCCGAGCTCCAGCTCGAGCGTATGAGCGTCTACTTCAACGAGGTTTGTTTCATCACTCCTGCCACGAAAACACAACAAGCTCACGCGCGCCTAGGCTTCCGGTAACAAGTATGTTCCCCGTGCCGTCCTCGTCGATCTCGAGCCCGGTACCATGGACGCCGTCCGTGCCGGTCCTTTCGGACAGCTTTTCCGTCCCGACAACTTCGTTTTCGGTCAATCCGGTGC
E01	TEF (EF1)	ACCCCGCCAGATGTGGAGGGGTAATTTCAACTTGAATATTTGCTGACAAGATTGCATAGACCGGTCACTTGATCTACCAGTGCGGTGGTATCGACAAGCGAACCATCGAGAAGTTCGAGAAGGTTGGTTTCCATTTCCCCGATCGCACGCCGTCTACCCACCGATTCATCAGTCGAATCAGTTACGACGATTGAATATGCGCCTGTTACCCCGCTCGAGTACAAAATTTTGCGGTTCAACCGTAATTTTTTTGGTGGGGTTTCAACCCCGCTACTCGAGCGACAGACGTTTGCCCTCTTCCCACAAACTCATGTCTCGTGCATCACGTGTCCATCAGCCACTAACCACCCGACAATAGGAAGCCGCCGAGCTCGGTAAGGGTTCCTTCAAGTACGCCTGGGTTCTTGACAAGCTCAAGGCTGAGCGTGAGCGTGGTATCACCATCGATATCGCCCTCTGGAAGTTCGAGACTC

		CTCGCTACTATGTCACCGTCATTGGTACGTTATCATCACTTA
E01	ITS (ITS1)	GGGGGGTAACGGGCTTCACTCCAAACCCCTGTGACATACCTAT ACGTTGCCTCGGCGGATCAGCCCGCGCCCCGTAAAACGGGAC GGCCCGCCCGAGGACCCCTAAACTCTGTTTTAGTGGAACTTC TGAGTAAAACAAACAAATAAATCAAAACTTTCAACAACGGAT CTCTTGGTTCTGGCATCGATGAAGAACGCAGCAAAATGCGATA AGTAATGTGAATTGCAGAATTCAGTGAATCATCGAATCTTTGA ACGCACATTGCGCCCGCCAGTATTCTGGCGGGCATGCCTGTTC GAGCGTCATTTCAACCCTCAAGCTCAGCTTGGTGTTGGGACTC GCGGTAACCCGCGTTCCCCAAATCGATTGGCGGTCACGTCGAG CTTCCATAGCGTAGTAATCATACACCTCGTTACTGGTAATCGT CGCGGCCACGCCGTAAAACCCCAACTTCTGAATGTTGACCTCG GATCAGGTAGGAATACCCGCTGAACTTAAGCATATCAATAGG CGGGAGGAA
E02	ITS (ITS1)	GGGAGTTCGGGGTAAACTCCAACCCCTGTGACATACCAATTGT TGCCTCGGCGGATCAGCCCGCTCCCGGTAAAACGGGACGGCC CGCCAGAGGACCCCTAAACTCTGTTTCTATATGTAACTTCTGA GTAAAACCATAAATAAATCAAAACTTTCAACAACGGATCTCTT GGTTCTGGCATCGATGAAGAACGCAGCAAAATGCGATAAGTA ATGTGAATTGCAGAATTCAGTGAATCATCGAATCTTTGAACGC ACATTGCGCCCGCCAGTATTCTGGCGGGCATGCCTGTTCGAGC GTCATTTCAACCCTCAAGCCCAGCTTGGTGTTGGGACTCGCGA GTCAAATCGCGTTCCCCAAATTGATTGGCGGTCACGTCGAGCT TCCATAGCGTAGTAGTAAAACCCTCGTTACTGGTAATCGTCGC GGCCACGCCGTTAAACCCCAACTTCTGAATGTTGACCTCGGAT CAGGTAGGAATACCCGCTGAACTTAAGCATATCAATAGGCGG TGGAAA
E03	ß-TUBULIN (BT2)	AGTACTCTCTGGCGAGCCGGTCTCGACAGCATGGTGTTTACAA CGGTACCTCCGAGCTCCAGCTCGAGCGCATGAGCGTCTACTTC AACGAGGTTTGTTCTATCACTCCTACCACGAAAACACAACAAG CTCACGCGCGCCTAGGCTTCCGGTAACAAGTATGTTCCCCGTG CCGTCCTCGTCGATCTCGAGCCCGGTACCATGGACGCCGTCCG TGCCGGTCCCTTCGGACAGCTTTTCCGTCCCGACAACTTCGTTT

		TCGGTCAATCCGGTGC
E03	TEF (EF1)	TCAACCCCGCCATACGTGGCGGGGTAATTTTAACTTGAATATC TGCTGATAAGATTGCATAGACCGGTCACTTGATCTACCAGTGA GGTGGTATCGACAAGCGAACCATCGAGAAGTTCGAGAAGGTT GGTTCCCATTCCCCTCGATCGCACGCTCTCTACCCTCCGATCTA TCAGTCGAATCAGTTTTACGACGATTGAATATGTGCCTGTTAC CCCGCTCGAGTACAAAATTTTGCGGTTCAACCGTAATTCTTTTG GTGGGGTTTCAACCCCGCTACTCGGGTGACAGGCGCTTGCCCT TCCCACAAATC
E03	ITS (ITS1)	GGGGGGCCCGGGGTTTCAACTCCCAACCCCTGTGACATACCTA TACGTTGCCTCGGCGGATCAGCCCGCGCCCCGTAAAACGGGAC GGCCCGCCCGAGGACCCTAAACTCTGTTTTTAGTGGAACTTCT GAGTAAAACAAACAAATAAATCAAAACTTTCAACAACGGATC TCTTGGTTCTGGCATCGATGAAGAACGCAGCAAAATGCGATAA GTAATGTGAATTGCAGAATTCAGTGAATCATCGAATCTTTGAA CGCACATTGCGCCCGCCAGTATTCTGGCGGGCATGCCTGTTCG AGCGTCATTTCAACCCTCAAGCTCAGCTTGGTGTTGGGACTCG CGGTAACCCGCGTTCCCCAAATCGATTGGCGGTCACGTCGAGC TTCCATAGCGTAGTAATCATACACCTCGTTACTGGTAATCGTC GCGGCCACGCCGTAAAACCCCAACTTCTGAATGTTGACCTCGG ATCAGGTAGGAATACCCGCTGAACTTAAGCATATCAATAGCCG GAGGAA
E04	ß-TUBULIN (BT2)	GGGTAATCTCTGGCGAGCCGGCCTCGACAGCAATGGTGTCTAC AATGGTACCTCCGAGCTTCAGCTCGAGCGCATGAGTGTTTACT TCAACGAGGTATGCATTAGCAGTCAATGTCAAGAGTTCACACG CTCACACATCTAGGCCTCTGGCAACAAGTATGTTCCCCGAGCC GTCCTCGTCGACCTCGAGCCTGGTACCATGGACGCCGTCCGTG CTGGTCCCTTCGGTCAGCTCTTCCGTCCCGACAACTTCGTTTTC GGTCAGTCCGGTGCTGGAAACAACTGGGCCAAGGGTCACTAC ACTGAGGGTA
E04	TEF (EF1)	CTGGCAGTCGACCACTGTGAGTACTACCCTTGACGATGAGCTT ATCGGCCATCGTAAACCCGGCCAAGACCTGGCGGGGGATTTCT

		CAAAGAAAACATGCTGACATCGCTTCACAGACCGGTCACTTGATCTACCAGTGCGGTGGTATCGACAAGCGAACCATCGAGAAGTTCGAGAAGGTTAGTCACTTTTCCTTCTATCGCGCGTTCTTTGCCCATCGATTCCCCCCTACGACTCGAAACGTACCCGCTACCCCGCTCGAGCCCAAAAATTTTGCGATACGACCGTAATTTTTTCTGGTGGGGCATTTACCCCGCCACTCGAGCGGCGCGTTTCTGCCCTCTCCCATTCCACAACCTCACTGAGCTCATCGTCACGTGTCAAGCAGTCACTAACCATCCGACAATAGGAAGCCGCTGAGCTCGGTAAGGGTTCCTTCAAGTACGCCTGGGTTCTTGACAAGCTCAAGGCCGAGCGTGAGCGTGGTATCACCATCGATATCGCTCTCTGGAAGTTCGAGACTCCTCGCTACTATGTCACCGTCATTGGTATGTTGTCGCTCTTATTCCGTTCTATATCTTCTATTACTAACACATCACATAGACGCTCCCGGTCACCGTGATTTCATCAAGAACATGATCACAAGT
E04	ITS (ITS1)	GGGGAAACGAGATTTCACTCCCAAACCCTGTGACATACCTATACGTTGCCTCGGCGGATCAGCCCGCGCCCCGTAAAACGGGACGGCCCGCCCGAGGACCCCTAAACTCTGTTTTTAGTGGAACTTCTGAGTAAAACAAACAAATAAATCAAAACTTTCAACAACGGATCTCTTGGTTCTGGCATCGATGAAGAACGCAGCAAAATGCGATAAGTAATGTGAATTGCAGAATTCAGTGAATCATCGAATCTTTGAACGCACATTGCGCCCGCCAGTATTCTGGCGGGCATGCCTGTTCGAGCGTCATTTCAACCCTCAAGCTCAGCTTGGTGTTGGGACTCGCGGTAACCCGCGTTCCCCAAATCGATTGGCGGTCACGTCGAGCTTCCATAGCGTAGTAATCATACACCTCGTTACTGGTAATCGTCGCGGCCACGCCGTAAAACCCCAACTTCTGAATGTTGACCTCGGATCAGGTAGGAATACCCGCTGAACTTAAGCATATAAATAGGCCGGAGGAA
E07	ITS (ITS1)	TGAGGTTCAATTGGATGCGGGCTGGACCTCTCGGGGTTACAGCCTTGCTGAATTATTCACCCTTGTCTTTTGCGTACTTCTTGTTTCCTTGGTGGGTTCGCCCACCACTAGGACAAACATAAACCTTTTGTAATTGCAATCAGCGTCAGTAACAAATTAATAATTACAACTTTCAACAACGGATCTCTTGGTTCTGGCATCGATGAAGAACGCAGCGAAATGCGATAAGTAGTGTGAATTGCAGAATTCAGTGAATCATCGAATCTTTGAACGCACATTGCGCCCTTTGGTATTCCAAAGGGC

		ATGCCTGTTCGAGCGTCATTTGTACCCTCAAGCTTTGCTTGGTG TTGGGCGTCTTGTCTCTAGCTTTGCTGGAGACTCGCCTTAAAGT AATTGGCAGCCGGCCTACTGGTTTCGGAGCGCAGCACAAGTCG CACTCTCTATCAGCAAAGGTCTAGCATCCATTAAGCCTTTTTTT CAACTTTTGACCTCGGATCAGGTAGGGATACCCGCTGAACTGA AACATATCAATAAATCGGAGGGC
E08	ß-TUBULIN (BT1)	GAGCGCTCATCATGAAGCCGTGGTGCTCACTCTTTCCGCGCTG TCAGCGTTCCTGAGCTGACCCAGCAGATGTTCGACCCCAAGAA CATGATGGCTGCTTCCGACTTCCGCAACGGTCGTTACCTGACC TGTTCTGCCATCTTCCGTGGCCGCGTCGCCATGAAGGAGGTCG AGGACCAGATGCGCAACGTTCAGAACAAGAACTCATCTTACTT CGTCGAGTGGATCCCTAACAACATCCAGACCGCTCTCTGCGCT ATTCCTCCTCGGGGACTTACTATGTCCTCTACCTTTATTGGAAA CTCCACCTCTATCCAGGAGCTTTTCAAGCGTGTTGGCGAGCAG TTTACTGCTATGTTCCGACGCAAGGCTTTCTTGCATTGGTACAC TGGTGAGGGTATGGACGAGATGGAGTTCACTGAGGCTGAGTT CAACATGAACGATCTCATCA
E08	TEF (EF1)	TGATTTGCTTATCAGCAGTCATCAACCCCGCCAGATGTGGCGG GGTAATTTCAACTTGAATATATGCTGACAAGATTGCATAGACC GGTCACTTGATCTACCAGTGCGGTGGTATCGACAAGCGAACCA TCGAGAAGTTCGAGAAGGTTGGTTTCCATTTCCCCGATCGCAC GCCGTCTACCCACCGATTCATCAGTCGAATCAGTTACGACGAT TGAATATGCGCCTGTTACCCCGCTCGAGTACAAAATTTTGCGG TTCAACCGTAAT
E08	ITS (ITS1)	GGGGGCTTCGAAACTTCACTCCCAACCCCTGTGACATACCTAT ACGTTGCCTCGGCGGATCAGCCCGCGCCCCGTAAAACGGGAC GGCCCGCCCGAGGACCCCTAAACTCTGTTTTTAGTGGAACTTC TGAGTAAAACAAACAAATAAATCAAAACTTTCAACAACGGAT CTCTTGGTTCTGGCATCGATGAAGAACGCAGCAAAATGCGATA AGTAATGTGAATTGCAGAATTCAGTGAATCATCGAATCTTTGA ACGCACATTGCGCCCGCCAGTATTCTGGCGGGCATGCCTGTTC GAGCGTCATTTCAACCCTCAAGCTCAGCTTGGTGTTGGGACTC GCGGTAACCCGCGTTCCCCAAATCGATTGGCGGTCACGTCGAG

		CTTCCATAGCGTAGTAATCATACACCTCGTTACTGGTAATCGT CGCGGCCACGCCGTAAAACCCCAACTTCTGAATGTTGACCTCG GATCAGGTAGGAATACCCGCTGAACTTAAGCATATCAATAGG CGGAGGAA
E11	ITS (ITS1)	GAGGGCACCAGATTTACTCCAAACCCCTGTGACATACCAATTG TTGCCTCGGCGGATCAGCCCGCTCCCGGTAAAACGGGACGGCC CGCCAGAGGACCCCTAAACTCTGTTTCTATATGTAACTTCTGA GTAAAACCATAAATAAATCAAAACTTTCAACAACGGATCTCTT GGTTCTGGCATCGATGAAGAACGCAGCAAAATGCGATAAGTA ATGTGAATTGCAGAATTCAGTGAATCATCGAATCTTTGAACGC ACATTGCGCCCGCCAGTATTCTGGCGGGCATGCCTGTTCGAGC GTCATTTCAACCCTCAAGCCCAGCTTGGTGTTGGGACTCGCGA GTCAAATCGCGTTCCCCAAATTGATTGGCGGTCACGTCGAGCT TCCATAGCGTAGTAGTAAAACCCTCGTTACTGGTAATCGTCGC GGCCACGCCGTTAAACCCCAACTTCTGAATGTTGACCTCGGAT CAGGTAGGAATACCCGCTGAACTTAAGCATATCAATAGGCGG AGGTAT
F12	ITS (ITS1)	GCGCTTCGAATACTTTGGTGTTGGTTGTAGCTGGCTCCTCGGA GCAATGTGCACGCCCGCCATTTTTATCTTTCCACCTGTGCACCG ACTGTAGGTCTGGATACCTCTCGCCTCCGGGCGGATGCGAGGG TTGCTCGAAAGGGCTTCCCTTGAACTTCCAGGCTCTACGTCTTT TTACACACCCCAATAGTATGATGCAGAATGTAGTCAATGGGCT TCTCAGCCTATAAAACACTATACAACTTTCAGCAACGGATCTC TTGGCTCTCGCATCGATGAAGAACGCAGCGAAATGCGATAAG TAATGTGAATTGCAGAATTCAGTGAATCATCGAATCTTTGAAC GCACCTTGCGCTCCTTGGTATTCCGAGGAGCATGCCTGTTTGA GTGTCATTAAATTCTCAACCTCACCAGTTTTCTGAACTGACTGA GGCTTGGATGTGGGGGTTTGTGCAGGCTGCCTCACGGCGGTCT GCTCCCCTGAAATGCATTAGCGAGGTTCATGCTGGACCTCCGT CTATTGGTGTGATAATTATCTACGCCGTGGACGAGGATACAGA CTCGCTTCTAATCGTCCGCGAGGACAATACCTTGACAATTTGA CCTCAAATCAGGTAGGACTACCCGAAAGAACTATAAACATAT CAATAATGGGGATGAATGTAGCTGGGTTCCTCGGAACAATGTT

		GCACGCCCCCTTTTTATCCTTTCTCCTGTGCACCGACTGGTAGG CCTGGATACCCCTCGCCTCCCGGCGGATGCGAAGGGTTGCTCC AAGGGCTTCCCTTGAACATCCAGGCTCTACGTCCTTTTACACC CCATAGTATGATGCGAAATTAGTCCATGGGCTCCCACCATTAA CTATACACTTCAGCAACGAACCTTGGCCTCGCATCGTTGATAA CACCAATGGATAGTATGTGATGCAAATCGTGATCTCAATCTTA CCTGCCCTGGTATTCCAGAACGCCGTTGAGTCATTAAGTCCAT CCAGTTCCGACTACTCAGCCTGAATGGGATTATGGCACGTCTC ACGGTCTGATCATACAGTACGACTCATAGCTGTATTAGC
F14	ß-TUBULIN (BT2)	AGGTTACTAATTCTGGCGAGCCGGTCTCGACAGCGATGGCCAG TACGTTTGTCGCCTATTCGTCCCCCCTCCCCTTCACGCCACCAT CCCATCCCGCTGCGGGAGGACAACAAACAAGGGACGATGGGA AGAACGCAGTCCACTGACAGGGGCCTTGCCACAGGTACAACG GCACCTCGGAGCTCCAGCTCGAGCGCATGAGCGTCTACTTCAA CGAGGCCTCGGGCAACAAGTACGTTCCCCGTGCCGTCCTCGTC GATCTCGAGCCCGGTACCATGGATGCTGTCCGCGCCGGTCCTT TCGGCCAGCTGTTCCGCCCCGACAACTTCGTCTTCGGCCAGTC TGGTGCTGGCAACAACTGGGCCAAGACATAATACACTGAGGG TA
F14	ITS (ITS1)	GGGGGCCTCGGACTATCCAACTCCCAAACCCATGTGAACTTAT CTCTTTGTTGCCTCGGCGCAAGCTACCCGGGACCTCGCGCCCC GGGCGGCCCGCCGGCGGACAAACCAAACTCTGTTATCTTAGTT GATTATCTGAGTGTCTTATTTAATAAGTCAAAACTTTCAACAA CGGATCTCTTGGTTCTGGCATCGATGAAGAACGCAGCGAAATG CGATAAGTAATGTGAATTGCAGAATTCAGTGAATCATCGAATC TTTGAACGCACATTGCGCCCATTAGTATTCTAGTGGGCATGCC TGTTCGAGCGTCATTTCAACCCCTAAGCACAGCTTATTGTTGG GAATCTACGCCCTAGTAGTTCCTCAAAGACATTGGCGGAGTGG CAGTAGTCCTCTGAGCGTAGTAATTCTTTATCTCGCTTTTGTTA GGTGCTGCCTCCCCGGCCGTAAAACCCCCAATTTTTCTGGTTG ACCTCGGATCAGGTAGGAATACCCGCTGAACTTAAGCATATCA ATAAGCGGAGGAA

F17	ß-TUBULIN (BT2)	GAGGACTTCCTCCTGGCGACCGGTCTCGACAGCAATGGTGTTTACAACGGTACCTCCGAGCTCCAGCTCGAGCGTATGAGCGTCTACTTCAACGAGGTTTGTTCCATCACTCCTGCCACGAAAACACAACAAGCTCACGCGCGCCTAGGCTTCCGGTAACAAGTATGTTCCCCGTGCCGTCCTCGTCGATCTCGAGCCCGGTACCATGGACGCCGTCCGTGCCGGTCCTTTCGGACAGCTCTTCCGTCCCGACAACTTCGTTTTCGGTCAGTCCGGTGCCGGAAACAACTGGGCCAAGGGTCACTACACTGAGGGT
F17	ß-TUBULIN (BT1)	AGGGGCCTATCATGACAGCCGTGGTGCTCACTCTTTCCGCGCTGTCAGCGTTCCTGAGCTGACCCAGCAGATGTTCGACCCCAAGAACATGATGGCTGCTTCCGACTTCCGCAACGGTCGTTACCTGACCTGCTCTGCCATCTTCCGGGGCCGCGTCGCCATGAAGGAGGTCGAGGACCAGATGCGCAACGTTCAGAACAAGAACTCATCTTACTTCGTCGAGTGGATCCCTAACAACATCCAGACCGCTCTCTGCGCTATTCCTCCTCGGGGACTTACTATGTCCTCTACCTTTATTGGAAACTCCACCTCTATCCAGGAGCTTTTCAAGCGTGTTGGCGAGCAGTTCACTGCTATGTTCCGACGCAAGGCTTTCTTGCATTGGTACACTGGTGAGGGTATGGACGAGATGGAGTTCACTGAGGCTGAGTTCAACATGAAAAATCTCATCA
F17	ITS (ITS1)	GGGGGGATTCGGAGCTTCACTCCCAACCCCTGTGACATACCTATACGTTGCCTCGGCGGATCAGCCCGCGCCCCGTAAAAAGGGACGGCCCGCCCGAGGACCCCTAAACTCTGTTTTTAGTGGAACTTCTGAGTAAAACAAACAAATAAATCAAAACTTTCAACAACGGATCTCTTGGTTCTGGCATCGATGAAGAACGCAGCAAAATGCGATAAGTAATGTGAATTGCAGAATTCAGTGAATCATCGAATCTTTGAACGCACATTGCGCCCGCCAGTATTCTGGCGGGCATGCCTGTTCGAGCGTCATTTCAACCCTCAAGCTCAGCTTGGTGTTGGGACTCGCGGTAACCCGCGTTCCCCAAATCGATTGGCGGTCACGTCGAGCTTCCATAGCGTAGTAATCATACACCTCGTTACTGGTAATCGTCGCGGCCACGCCGTAAAACCCCAACTTCTGAATGTTGACCTCGGATCAGGTAGGAATACCCGCTGAACTTAAGCATATCAATAGGCGGAGGA

F19	ß-TUBULIN (BT2)	GGGTCTCTCTGGCGAGCCGGTCTCGACAGCAATGGTGTTTACAACGGTACCTCCGAGCTCCAGCTCGAGCGTATGAGCGTCTACTTCAACGAGGTTTGTTTCATCACTCCTGCCACGAAAACACAACAAGCTCACGCGCGCCTAGGCTTCCGGTAACAAGTATGTTCCCCGTGCCGTCCTCGTCGATCTCGAGCCCGGTACCATGGACGCCGTCCGTGCCGGTCCTTTCGGACAGCTTTTCCGTCCCGACAACTTCGTTTTCGGTCAATCCGGTGCCGGAAACAACTGGGCCAAGGGTCACTACACTGAGGGTTACACCGAACGTGAAGAAGTCATTATGATCAACCGAATTCTCCGAGACGATCCGGCCAAGGGTCACTACACTGAGGGT
F19	ITS (ITS1)	GGGAGTCAAGGAATTCACTCCCAACCCCTGTGACATACCTATACGTTGCCTCGGCGGATCAGCCCGCGCCCCGTAAAACGGGACGGCCCGCCCGAGGACCCCTAAACTCTGTTTTTAGTGGAACTTCTGAGTAAAACAAACAAATAAATCAAAACTTTCAACAACGGATCTCTTGGTTCTGGCATCGATGAAGAACGCAGCAAAATGCGATAAGTAATGTGAATTGCAGAATTCAGTGAATCATCGAATCTTTGAACGCACATTGCGCCCGCCAGTATTCTGGCGGGCATGCCTGTTCGAGCGTCATTTCAACCCTCAAGCTCAGCTTGGTGTTGGGACTCGCGGTAACCCGCGTTCCCCAAATCGATTGGCGGTCACGTCGAGCTTCCATAGCGTAGTAATCATACACCTCGTTACTGGTAATCGTCGCGGCCACGCCGTTAAACCCCAACTTCTGAATGTTGACCTCGGATCAGGTAGGAATACCCGCTGAACTTAAGCATATCAATAAGTCGGAGGAA
F20	ß-TUBULIN (BT2)	GATTAATTCTCTGGCGAGCCGGTCTCGACAGCAATGGTGTTTATAACGGTACCTCCGAGCTCCAGCTCGAGCGTATGAGCGTCTACTTCAACGAGGTTTGTTTCATCACTCCTGCTACGAAAACACAACAAGCTCACGCGCGCTTAGGCTTCCGGTAACAAGTATGTTCCCCGTGCCGTCCTCGTCGATCTCGAGCCCGGTACCATGGACGCCGTCCGTGCCGGTCCTTTCGGACAGCTTTTCCGTCCCGACAACTTCGTTTTCGGTCAATCCGGTGCCGGAAACAACTGGGCCAAGGGTCACAACAAATGAGGGTA
F20	TEF	AATATTTGCTGACAAGATTGCAAAGACCGGTCACTTGATCTAC

	(EF1)	CAGTGCGGTGGTATCGACAAGCGAACCATCGAGAAG
F20	ITS (ITS1)	GGGGAGATGGGACTTCACTCCAAACCCCTGTGACATACCTATACGTTGCCTCGGCGGATCAGCCCGCGCCCCGTAAAACGGGACGGCCCGCCCGAGGACCCCTAAACTCTGTTTTTAGTGGAACTTCTGAGTAAAACAAACAAATAAATCAAAACTTTCAACAACGGATCTCTTGGTTCTGGCATCGATGAAGAACGCAGCAAAATGCGATAAGTAATGTGAATTGCAGAATTCAGTGAATCATCGAATCTTTGAACGCACATTGCGCCCGCCAGTATTCTGGCGGGCATGCCTGTTCGAGCGTCATTTCAACCCTCAAGCTCAGCTTGGTGTTGGGACTCGCGGTAACCCGCGTTCCCCAAATCGATTGGCGGTCACGTCGAGCTTCCATAGCGTAGTAATCATACACCTCGTTACTGGTAATCGTCGCGGCCACGCCGTAAAACCCCAACTTCTGAATGTTGACCTCGGATCAGGTAGGAATACCCGCTGAACTTAAGCATATCAATAGTCGGAGGAA
F21	ß-TUBULIN (BT2)	GGGGACTCTCTGGCGAGCCGGTCTCGACAGCAATGGTGTTTACAACGGTACCTCCGAGCTCCAGCTCGAGCGTATGAGCGTCTACTTCAACGAGGTTTGTTTTATCTCTCCTGCCACGAAAACACAACAAGCTCACGCGCGCCTAGGCTTCCGGTAACAAGTATGTTCCCCGTGCCGTCCTCGTCGATCTCGAGCCCGGTACCATGGACGCTGTCCGTGCTGGTCCTTTCGGACAGCTTTTCCGTCCCGACAACTTCGTTTTCGGTCAATCCGGTGCCGGAAACAACTGGGCCAAGGGTCACTACACTGAGGGTA
F21	ITS (ITS1)	GGGGGAACTGAATTCACTCCCAACCCCTGTGACATACCTATACGTTGCCTCGGCGGATCAGCCCGCGCCCTGTAAAACGGGACGGCCCGCCCGAGGACCCTAAACTCTGTTTTTAGTGGAACTTCTGAGTAAAACAAACAAATAAATCAAAACTTTCAACAACGGATCTCTTGGTTCTGGCATCGATGAAGAACGCAGCAAAATGCGATAAGTAATGTGAATTGCAGAATTCAGTGAATCATCGAATCTTTGAACGCACATTGCGCCCGCCAGTATTCTGGCGGGCATGCCTGTTCGAGCGTCATTTCAACCCTCAAGCTCAGCTTGGTGTTGGGACTCGCGGTAACCCGCGTTCCCCAAATCGATTGGCGGTCACGTCGAGCTTCCATAGCGTAGTAATCATACACCTCGTTACTGGTAATCGTCGCGGCCACGCCGTAAAACCCCAACTTCTGAATGTTGACCTCGGA

		TCAGGTAGGAATACCCGCTGAACTTAAGCATATCAATAGCCGG AGGAAT
F22	ITS (ITS1)	GGGCATGAAGTTTCTAACTCCACCCATGTGACTTACCTTTTGTT GCCTCGGCAGAAGTTATAGGTCTTCTTATAGCTGCTGCCGGTG GATCATTAAACTCTTGTTATTTTATGTAATCTGAGCGTCTTATT TTAATAAGTCAAAACTTTCAACAACGGATCTCTTGGTTCTGGC ATCGATGAAGAACGCAGCGAAATGCGATAAGTAATGTGAATT GCAGAATTCAGTGAATCATCGAATCTTTGAACGCACATTGCGC CCATTAGTATTCTAGTGGGCATGCCTGTTCGAGCGTCATTTCA ACCCTTAAGCCTAGCTTAGTGTTGGGAATCTACTTCTCTTAGG AGTTGTAGTTCCTGAAATACAACGGCGGATTTGTAGTATCCTC TGAGCGTAGTAATTTTTTTCTCGCTTTTGTTAGGTGCTATAACT CCCAGCCGCTAAACCCCCAATTTTTGTGGTTGACCTCGGATC AGGTAGGAATACCCGCTGAACTTAAGCATATCAATAGGCGGG AGGAA
F22	ß-TUBULIN (BT2)	CCTCATACGACGTTTTTCGTGCCTGCACGACAGCCCCGAACAG TGAATTAGGTCAAGATAGAGGGAACATGATGCTAATAGGTCA TTGATAGGCAAACCATCTCTGGCGAGCACGGTCTCGACAGCAA TGGAGTGTATGTACTATTTTCAATTCCTCCTGCTTCCTGTTGAG CTTGTAGGCTGACTCGATGGCCATTTAGCTACAACGGTACATC CGAGCTCCAGCTCGAGCGTATGAGCGTCTACTTCAACGAGGCT TCCGGCAACAAGTACGTTCCTCGTGCCGTCCTCGTCGATCTCG AGCCCGGTACCATGGATGCCGTCCGCGCCGGTCCCTTCGGCCA GCTCTTCCGCCCTGACAACTTCGTCTTCGGTCAGTCCGGTGCTG GCAACAACTGGGCCAAGGGTCACTACACTGAGGGT
F23	ß-TUBULIN (BT2)	GCGTTTCTTCTCTATACTCGACACAACCACTGCCTCTGCAACG AAGACGAAGACGACCGCATATCCACGAATTTTCGGAAGGCTT CGGTCGCAAGTGCTTGGGAGGCCAGATTGAGACTGGTGAGGC TAACGTTCTTACCCGAATACAGGCAGACCATCTCCAGCGAGCA CGGTCTCGACAGCAATGGCGTGTAAGTACAACGATCTGCTCGC GGTCCTTCTTCCCTTCTGGAGGGCGGTAGATTCTATGTCACCTG AAAGAAATCAATGCTGACACTGCGTCAATAGCTACAACGGCA CCTCCGAGCTCCAGCTCGAGCGCATGAGCGTCTACTTCAACGA

		GGTAATTCACTTCGAAGCCAAATCATGACCGAGCAGACGCCTAATCACAATGTCTTCTAGGCCTCTGGCAACAAGTACGTCCCTCGCGCCGTTCTCGTCGATCTCGAGCCCGGTACCATGGACGCCGTCCGTGCTGGCCCCTTCGGTCAGCTCTTCCGCCCCGACAACTTCGTCTTCGGTCAGTCTGGTGCTGGCAACAAGTGGGACCAGGATCACTACACTGAGGGTAA
F23	ITS (ITS1)	TCGGATTCAGGGGTTTTACTCTCCAACCATGTGACTTACCACTGTTGCCTCGGTGGTTTGGTCTTCGGACTGACCACCGGCGGACCACTAAACTCTTGTTAATTTATGGCATTCTGAATCATAACTAAGAAATAAGTTAAAACTTTCAACAACGGATCTCTTGGTTCTGGCATCGATGAAGAACGCAGCGAAATGCGATAAGTAATGTGAATTGCAGAATTCAGTGAATCATCGAATCTTTGAACGCACATTGCGCCCATTAGTATTCTAGTGGGCATGCCTGTTCGAGCGTCATTTCAACCCTTAAGCCTAGCTTAGTGTTGGGAGACTGCCTAATACGCAGCTCCTCAAAACCAGTGGCGGAGTCTGTTCGTGCTCTGAGCGTAGTAATTCTTTATCTCGCTTCTGCAAGCCGGCCAGACGACAGCCATAAACCGCACCCTCTCGGGGGGCACTTTTTTGATGGATGACCTCGGATGAGGGAGGAATACCCGCTGATCTTGAGAATATCAATAGGGAGGAAGAACTC
F25	ß-TUBULIN (BT2)	TAGTCTCTCTGGCGAGCCGGCCTCGACAGCAATGGTGTCTACAACGGTACCTCCGAGCTCCAGCTCGAGCGCATGAGTGTCTACTTCAACGAGGTATGCATTAACAGTCAATGCCAATAATTCCCAAGCTCACACAACTAGGCCTCTGGCAACAAGTATGTTCCCCGAGCCGTCCTCGTCGATCTTGAGCCTGGTACCATGGACGCCGTCCGTGCTGGTCCCTTTGGTCAGCTCTTCCGTCCCGACAACTTCGTTTTCGGTCAGTCCGGTGCTGGAAACAACTGGGCCAAGGGTCACTACACTGAGGGTA
F25	ß-TUBULIN (BT1)	GAGCGCCTTGCTCTCTGAAGCCGTGGTGCTCACTCTTTCCGCGCTGTCAGTGTTCCTGAGTTGACCCAACAGATGTTCGACCCCAAGAACATGATGGCTGCTTCGGACTTCCGTAACGGTCGCTACCTGACCTGCTCGGCCATTTTGTGAGTGAACTCGATTTTGCACATGAGAACTATTTACTGACTTTACATAGCCGTGGCCGTGTCGCTATGAAGGAGGTCGAGGACCAAATGCGCAACGTCCAGGCCAAGAAC

		TCTTCTTACTTCGTTGAATGGATTCCCAACAATATCCAGACAGCCCTTTGTGCCATCCCTCCCCGAGGACTTACGATGTCTTCGACTTTCATCGGAAATTCCACCTCTATCCAGGAGCTCTTCAAGCGTGTTGGTGAGCAGTTCACTGCTATGTTCCGACGCAAGGCTTTCTTGCATTGGTATACTGGTGAGGGTATGGACGAGATGGAGTTCACTGAGGCTGAGTTCAACATGAACGATCTCATCA
F25	TEF (EF1)	ACTCTGGCAGTCGACCACTGTGAGTACTACCCTCGATGATGAGCTTATCTGCCATCGAAACCCTCACCAAGACCTGGCGGGGTATTCCTCTTGAAACAAGATGCTGACATGGCTACACAGACCGGTCACTTGATCTACCAGTGCGGTGGTATCGACAAGCGAACCATCGAGAAGTTCGAGAAGGTTAGTCACTTTCCCTTCGATCGCGCGTCCTTTGTACATCGATTTCCCCTACGACTCGAAACGTGCCCGCTACCCCGCTCGAGACCAAAAATTTTGCGATATGACCGTAATTTTTTTGGTGGGGCATTTACCCCGCCACTCGAGCGATGGGCGCGTTTTTGCCCTTTCCTAGCCACAACTTCAATGAGCGCATCATCACGTGTCAAGCAGTCACTAACCATCTGACAATAGGAAGCCGCTGAGCTCGGTAAGGGTTCCTTCAAGTACGCCTGGGTTCTTGACAAGCTCAAGGCCGAGCGTGAGCGTGGTATCACCATCGATATTGCTCTCTGGAAGTTCGAGACTCCCCGCTACTATGTCACCGTCATTGGTATGTTGTCGCTCATGCCTCACTCTATTTCCTAGTACTAACATGTCACTCAGACGCTCCCGGTCACCGTGACTAAAAA
F25	ITS (ITS1)	GGGGGGGTTCAGGCTTCACTCCAAACCCCTGTGACATACCAATTGTTGCCTCGGCGGATCAGCCCGCTCCCGGTAAAACGGGACGGCCCGCCAGAGGACCCCCAAACTCTGTTTCTATATGTAACTTCTGAGTAAAACCATAAATAAATCAAAACTTTCAACAACGGATCTCTTGGTTCTGGCATCGATGAAGAACGCAGCAAAATGCGATAAGTAATGTGAATTGCAGAATTCAGTGAATCATCGAATCTTTGAACGCACATTGCGCCCGCCAGTATTCTGGCGGGCATGCCTGTTCGAGCGTCATTTCAACCCTCAAGCCCAGCTTGGTGTTGGGACTCGCGAGTCAAATCGCGTTCCCCAAATTGATTGGCGGTCACGTCGAGCTTCCATAGCGTAGTAGTAAAACCCTCGTTACTGGTAATCGTCGCGGCCACGCCGTTAAACCCCAACTTCTGAATGTTGACCTCGGATCAGGTAGGAATACCCGCTGAACTTAAGCATATCAATAGTC

		GGAGGAA
F27	ß-TUBULIN (BT2)	GGTGGCTTCTTCTGGCGAGCCGGCCTCGACAGCAATGGTGTCTACAACGGTACCTCCGAGCTCCAGCTCGAGCGCATGAGTGTCTACTTCAACGAGGTATGCATTAACAGTCAATGCCAATAATTCCCAAGCTCACACAACTAGGCCTCTGGCAACAAGTATGTTCCCCGAGCCGTCCTCGTCGATCTTGAGCCTGGTACCATGGACGCCGTCCGTGCTGGTCCCTTTGGTCAGCTCTTCCGTCCCGACAACTTCGTTTTCGGTCAGTCCGGTGCTGGAAACAACTGGGCCAAGGGTCACAACAATGAGGGTA
F27	TEF (EF1)	CGACCACTGTGAGTACTACCCTCGATGATGAGCTTATCTGCCATCGAAACCCTCACCAAGACCTGGCGGGGTATTCCTCTTGAAACAAGATGCTGACATGGCTACACAGACCGGTCACTTGATCTACCAGTGCGGTGGTATCGACAAGCGAACCATCGAGAAGTTCGAGAAGGTTAGTCACTTTCCCTTCGATCGCGCGTCCTTTGTACATCGATTTCCCCTACGACTCGAAACGTGCCCGCTACCCCGCTCGAGACCAAAAATTTTGCGATATGACCGTAATTTTTTGGTGGGGCATTTACCCCGCCACTCGAGCGATGGGCGCGTTTTTGCCCTTTCCTAGCCACAACTTCAATGAGCGCATCATCACGTGTCAAGCAGTCACTAACCATCTGACAATAG
F27	ITS (ITS1)	TGGGGCTTAAGAGCTTCACTCCCAACCCCTGTGACATACCAATTGTTGCCTCGGCGGATCAGCCCGCTCCCGGTAAAACGGGACGGCCCGCCAGAGGACCCCCAAACTCTGTTTCTATATGTAACTTCTGAGTAAAACCATAAATAAATCAAAACTTTCAACAACGGATCTCTTGGTTCTGGCATCGATGAAGAACGCAGCAAAATGCGATAAGTAATGTGAATTGCAGAATTCAGTGAATCATCGAATCTTTGAACGCACATTGCGCCCGCCAGTATTCTGGCGGGCATGCCTGTTCGAGCGTCATTTCAACCCTCAAGCCCAGCTTGGTGTTGGGACTCGCGAGTCAAATCGCGTTCCCCAAATTGATTGGCGGTCACGTCGAGCTTCCATAGCGTAGTAGTAAAACCCTCGTTACTGGTAATCGTCGCGGCCACGCCGTTAAACCCCAACTTCTGAATGTTGACCTCGGATCAGGTAGGAATACCCGCTGAACTTAAGCATATCAATAGACGGGAGGAA

F28	ß-TUBULIN (BT2)	AGCTTTCTTTTTTTCTTCACTCGGCACACCGCTGCCTCTGCAACGAGGACGAAGAAGACCGCATATCGACGAACTTTCGAAAGGCTTCGGTCGCAAGTGCTTGGGAGGCCAGATTGAGACTGGTGAGGCTAACGATCTTACCCGAATACAGGCAGACCATCTCCAGCGAGCACGGTCTCGACAGCAATGGCGTGTAAGTACAACGGTCTGCTCGCGGTCCTTGTCCCCTTCTGAAGGGCGGCAGATTCTATGTCACTTAAGGGAATCCATGCTGACATTGCGTCAACAGCTACAACGGCACCTCCGAGCTCCAGCTCGAGCGCATGAGCGTCTACTTCAACGAGGTAATTTACTTCGAAGCCAGATCATGACCGAGCAGACGCCTAATCACAATGTCTCCTAGGCCTCCGGCAACAAGTACGTCCCTCGCGCCGTTCTCGTCGATCTCGAGCCCGGTACCATGGACGCCGTCCGTGCTGGCCCCTTCGGTCAGCTCTTCCGCCCCGACAACTTCGTCTTCGGTCAGTCCGGTGCTGGCAACAACTGGGAAAAAGGTCACTACAC
F28	ITS (ITS1)	GGGGATTCGGAAATTTACTCTCCAACCATGTGACTTACCACTGTTGCCTCGGTGGTTTGGTCTTCGGACTGACCACCGGCGGACCACTAAACTCTTGTTAATTTATGGCATTCTGAATCATAACTAAGAAATAAGTTAAAACTTTCAACAACGGATCTCTTGGTTCTGGCATCGATGAAGAACGCAGCGAAATGCGATAAGTAATGTGAATTGCAGAATTCAGTGAATCATCGAATCTTTGAACGCACATTGCGCCCATTAGTATTCTAGTGGGCATGCCTGTTCGAGCGTCATTTCAACCCTTAAGCCTAGCTTAGTGTTGGGAGACTGCCTAATACGCAGCTCCTCAAAACCAGTGGCGGAGTCTGTTCGTGCTCTGAGCGTAGTAATTCTTTATCTCGCTTCTGTAAGCCGGTCAGACGACAGCCATAAACCGCACCCTTCGGGGGCACTTTTTAATGGTTGACCTCGGATCAGGTAGGAATACCCGCTGAACTTAAGCATATCAATAGGCGTTAGTA
F30	ß-TUBULIN (BT2)	GTTTTCAATTTTCTGGCGAGCCGGTCTCGACAGCAATGGTGTCTACAACGGCACCTCCGAGCTCCAGCTCGAGCGTATGAGCGTTTACTTCAACGAGGTATGCAGATTCGACCCGAATCCCAATAACCAGGGTCCCGTACTCACCTCACCGCATGTAGGCTTCCGGCAACAAGTATGTCCCTCGCGCCGTCCTCGTCGATCTTGAGCCTGGTACCATGGATGCTGTCCGTGCCGGTCCTTTTGGCCAGCTCTTCCGTCC

		CGACAACTTCGTCTTCGGTCAGTCCGGTGCCGGAAACAACTGG GCCAAGGGTCACTACACTGAGGGTA
F30	ITS (ITS1)	GGGGGACTTCGAACTTCACTCCCCAACCCCTGTGACATACCTA CAACGTTGCCTCGGCGGACCCCCGCCTCCCCGTAACACGGGAG CGGCCCGCCAGAGGACCCAACAAACCCTGTTATTTTCAGTATC TTCTGAGTGAAAACACAATCAATTAAAACTTTCAACAACGGAT CTCTTGGTTCTGGCATCGATGAAGAACGCAGCGAAATGCGATA AGTAATGTGAATTGCAGAATTCAGTGAATCATCGAATCTTTGA ACGCACATTGCGCCCGCCAGTACTCTGGCGGGCATGCCTGTTC GAGCGTCATTACATCCCTCAAGCCCCTCCGGGCTTGGTGTTGG GCATCGGCCGTCCCTCCAGCGGCGGCCGTGCCCCAAATACAGT GGCGGTCTCGCCCCCGGCTCCTCTGCGTAGTAGTAACATCTCG CACTGGGACGGAGCGTAGGCCACGCCGTAAAACAACCCAACT TTCTGAATGTTGACCTCGGATCAGGTAGGAATACCCGCTGAAC TTAAGCATATCAATAGTCGGAGGAA
F31	ß-TUBULIN (BT2)	GTTGACTCTCTGGGCGAGCACGGCCTCGACAGCATGGTGTCTA CAATGGTACCTCCGAGCTTCAGCTCGAGCGCATGAGTGTTTAC TTCAACGAGGTATGCATTAGCAGTCAATGTCAAGAGTTCCCAC GCTCACACATCTAGGCCTCTGGCAACAAGTATGTTCCCCGAGC CGTCCTCGTCGACCTCGAGCCTGGTACCATGGACGCCGTCCGT GCTGGTCCCTTCGGTCAGCTCTTCCGTCCCGACAACTTCGTTTT CGGTCAGTCCGGTGCCGGAAACAACTGGGCCAAGGGTCACTA CACTGAGGGTA
F31	TEF (EF1)	ACCACTGTGAGTACTACCCTTGACGATGAGCTTATCGGCCATC GTAAACCCGGCCAAGACCTGGCGGGGTATTTCTCAAAGAAGA CATGCTGACATCGCTTCACAGACCGGTCACTTGATCTACCAGT GAGGTGGTATCGACAAGCGAACCATCGAGAAGTTCGAGAAGG TTAGTCACTTTTCCTTCTATCGCGCGTTCTTTGCCCATCGATTTC CCCCTACGACTCGAAACGTACCCGCTACCCCGCTCGAGCCCAA AAATTTTGCGATATGACCGTAATTTTTCTGGTGGAGCATTTACC CCGCCACTCGAGCGGCGCGTTTCTGCCCTCTCCCATTCCACAA CCTCACTGAGCTCATCGTCACGTGTCAAGCAGTCACTAACCAT CCGACAATAGGAAGCCGCTGAGCTCGGTAAAGGTTCCTTCAA

		GTACGCCTGGGTTCTTGACAAGCTCAAGGCCGAGCGTGAGCGT GGTATCACCATCGATATCGCTCTCTGGAAGTTCGAGACTCCTC GCTACTATGTCACCGTCATTGGTATGTCGTCGCTCTTACTCCGT TTTATATCTCCTATTACTAACACATCACATAGACGCTCCCGGTC ACCGTGATTTCATCAAGAAC
F31	ITS (ITS1)	GGGGGATCCAGGTTTACTCCCAAACCCCTGTGACATACCAATT GTTGCCTCGGCGGATCAGCCCGCTCCCGGTAAAACGGGACGG CCCGCCAGAGGACCCCTAAACTCTGTTTCTATATGTAACTTCT GAGTAAAACCATAAATAAATCAAAACTTTCAACAACGGATCT CTTGGTTCTGGCATCGATGAAGAACGCAGCAAAATGCGATAA GTAATGTGAATTGCAGAATTCAGTGAATCATCGAATCTTTGAA CGCACATTGCGCCCGCCAGTATTCTGGCGGGCATGCCTGTTCG AGCGTCATTTCAACCCTCAAGCCCAGCTTGGTGTTGGGACTCG CGAGTCAAATCGCGTTCCCCAAATTGATTGGCGGTCACGTCGA GCTTCCATAGCGTAGTAGTAAAACCCTCGTTACTGGTAATCGT CGCGGCCACGCCGTTAAACCCCAACTTCTGAATGTTGACCTCG GATCAGGTAGGAATACCCGCTGAACTTAAGCATATCAATAGG CGGAGGAAA
F33	ß-TUBULIN (BT2)	AGGTCCTTCTCTGGCGAGCCGGCCTCGACAGCAATGGTGTCTA CAACGGTACCTCCGAGCTTCAGCTCGAGCGCATGAGTGTTTAT TTCAACGAGGTATGCATTAGCAGTCAATGTCAAGAGTTCCCAA GCTCACACATCTAGGCCTCTGGCAACAAGTATGTTCCCCGAGC CGTCCTCGTCGATCTCGAGCCCGGTACCATGGACGCCGTCCGT GCTGGTCCCTTCGGTCAGCTCTTCCGTCCTGACAACTTCGTTTT TGGTCAGTCCGGTGCTGGAAACAACTGGGCCAAGGGTCACAA CACTGAGGGTA
F33	ß-TUBULIN (BT1)	AAGGTGCTTTTTCTCTGACAGCCGTGGTGCTCACTCTTTCCGCG CTGTCAGTGTTCCTGAGTTGACCCAACAGATGTTCGACCCCAA GAACATGATGGCTGCTTCGGACTTCCGCAATGGTCGCTACCTG ACCTGCTCGGCCATTTTGTGAGTGAACCCGATTTTGCATATGG AAATTATTTACTGACTTTGCATAGCCGTGGCCGTGTCGCTATG AAGGAGGTCGAGGACCAGATGCGCAACGTCCAGAGCAAGAAC TCTTCTTACTTCGTTGAATGGATTCCCAACAACATCCAGACAG

		CCCTTTGTGCCATCCCTCCCCGAGGACTTACGATGTCTTCGACC TTCATCGGAAACTCTACTTCTATCCAGGAGCTCTTCAAGCGTG TTGGTGAGCAGTTCACTGCCATGTTCCGACGCAAGGCTTTCTT GCATTGGTATACTGGTGAGGGCATGGACGAGATGGAGTTCACT GAGGCTGAGTTCAACATGAACGATCTCATCA
F33	TEF (EF1)	TACTCTGGCAGTCAAGAACCACTGTGAGTACTACCCTCGACGA TGAAGCTTATCTGCCATCATAATCCCGACCAAAACCTGGCGGG GTATTTCTCAAAAGCCAACATGCTGACATTACTTCACAGACCG GTCACTTGATCTACCAGTGCGGTGGTATCGACAAGCGAACCAT CGAGAAGTTCGAGAAGGTTAGTCACTTTCCCTTCGATCGCGCG TCCTTTATCCATCGATTTCCCCTACGACTCGAAACTTGCCCGCT ACCCCGCTCGAGTCCAAAATTTTTGCGATATGACCGTAATTTTT TTGGTGGGGCCTTTACCCCGCCACTCGAGCGGCGCGTTTTTGC CCTCTCTCATTCCACAACCTCACTGAGCGCATCGTCACGTGTC AAGTAGTCACTAACCGTTCGACAATAGGAAGCCGCTGAGCTC GGTAAGGGTTCCTTCAAGTACGCCTGGGTTCTTGACAAGCTCA AGGCCGAGCGTGAGCGTGGTATCACCATCGATATTGCTCTCTG GAAGTTCGAGACTCCTCGCTACTATGTCACCGTCATTGGTATG TTGCCGCTCATGCTTCATTCTACATCTCTTCTTACTAACATATC GCTCAGACGCTCCCGGTCACCGTGATTTCATCAAGAACATGAT CACTGGTACTTCCGGAAGTACCAGTGATCATGTTCTTGATGAA ATCACGGTGACCGGGAGCGTCTGAGCGATATGTTAGTAAGAA GAGATGTAGAATGAAGCATGAGCGGCAACATACCAATGACGG TGACATAGTAGCGAGGAGTCTCGAACTTCCAGAGAGCAATAT CGATGGTGATACCACGCTCACGCTCGGCCTTGAGCTTGTCAAG AACCCAGGCGTACTTGA
F33	ITS (ITS1)	GGGGGATCGGGTTAACTCCAAACCCCTGTGACATACCAATTGT TGCCTCGGCGGATCAGCCCGCTCCCGGTAAAACGGACGGCC CGCCAGAGGACCCCTAAACTCTGTTTCTATATGTAACTTCTGA GTAAAACCATAAATAAATCAAAACTTTCAACAACGGATCTCTT GGTTCTGGCATCGATGAAGAACGCAGCAAAATGCGATAAGTA ATGTGAATTGCAGAATTCAGTGAATCATCGAATCTTTGAACGC ACATTGCGCCCGCCAGTATTCTGGCGGGCATGCCTGTTCGAGC

		GTCATTTCAACCCTCAAGCCCAGCTTGGTGTTGGGACTCGCGA GTCAAATCGCGTTCCCCAAATTGATTGGCGGTCACGTCGAGCT TCCATAGCGTAGTAGTAAAACCCTCGTTACTGGTAATCGTCGC GGCCACGCCGTTAAACCCCAACTTCTGAATGTTGACCTCGGAT CAGGTAGGAATACCCGCTGAACTTAAGCATATCAATAAGCCG GATGAAA
F34	ß-TUBULIN (BT1)	GGGGTAACCTCATGACAGCCGTGGTGCTCACTCTTTCCGCGCT GTCAGCGTTCCCGAGCTTACCCAGCAGATGTTCGATCCCAAGA ACATGATGGCTGCTTCTGACTTCCGCAACGGTCGTTACCTGAC CTGCTCTGCCATCTTCCGTGGCCGTGTCGCCATGAAGGAGGTT GAGGACCAGATGCGCAACGTCCAGAACAAGAACTCATCATAC TTTGTCGAGTGGATCCCGAACAACATCCAGACCGCTCTCTGCG CTATTCCCCCTCGTGGACTTACTATGTCCTCCACTTTTATTGGA AACTCCACCTCTATCCAGGAGCTTTTCAAGCGTGTTGGCGAGC AGTTCACTGCCATGTTCCGACGCAAGGCTTTCTTGCATTGGTA CACTGGTGAAGGTATGGACGAGATGGAGTTCACTGAGGCTGA GTTCAACATGAACGATCTCATC
F34	ITS (ITS1)	GGGAGAACGGGAATTCACTCCAAACCCCTGTGACATACCTATA CGTTGCCTCGGCGGATCAGCCCGCGCCCCGTAAAACGGGACG GCCCGCCGCAGGACCCCACAAACCCTGAATTTTATTGTAACTT CTGAGTTTAAAAAACAAATAAATCAAAACTTTCAACAACGGA TCTCTTGGTTCTGGCATCGATGAAGAACGCAGCAAAATGCGAT AAGTAATGTGAATTGCAGAATTCAGTGAATCATCGAATCTTTG AACGCACATTGCGCCCGCCAGTATTCTGGCGGGCATGCCTGTT CGAGCGTCATTTCAACCCTCAAGCCCCCGGGTTTGGTGTTGGG GATCGGGCTGCGGTTCTGCCGCGTCCCGGCCCCGAAATCTAGT GGCGGTCTCGCTGCAGCCTCCATTGCGTAGTAGCTAACACCTC GCAACTGGAACGCGGCGCGGCCAAGCCGTTAAACCCCCAACT TCTGAATGTTGACCTCGGATCAGGTAGGAATACCCGCTGAACT TAAGCATATCAATAAGGCGGAGGAA
F35	ß-TUBULIN	ATTACTAGAATTCTTGGCGAGCCGGTCTCGACAGCGATGGCCA GTACGTTTTTCTCGACTACCCCTCCTGCCCTCCTCTCCCCTCCC CATCGCACCGTCATCGCGTCGCGGTGGGGTAGAGGAAAAACA

	(BT2)	AACAAGAGGTGATGCGATGGAGGAAGAAGAAAACCGACCACT GACAATGCCCTTGCTACAGGTACAACGGCACCTCGGAGCTCCA GCTCGAGCGTATGAGCGTCTACTTTAACGAGGCCTCGGGCAAC AAGTACGTCCCCCGTGCCGTCCTCGTCGATCTCGAGCCCGGCA CCATGGACGCTGTCCGCGCCGGTCCTTTCGGTCAGCTGTTCCG TCCCGACAACTTCGTTTTCGGCCAGTCGGGTGCTGGCAACAAC TGGGCCAAGGGTCACTACACTGAGGGTA
F35	ITS (ITS1)	GGGGGCCGGGGTTTCCACTCCAAACCCATGTGACATATCTCTT TGTTGCCTCGGCGCAAGCTACCCGGGACCTCGCGCCCCGGGCG GCCCGCCGGCGGACAAACCAAACTCTGTTATCTTCGTTGATTA TCTGAGTGTCTTATTTAATAAGTCAAAACTTTCAACAACGGAT CTCTTGGTTCTGGCATCGATGAAGAACGCAGCGAAATGCGATA AGTAATGTGAATTGCAGAATTCAGTGAATCATCGAATCTTTGA ACGCACATTGCGCCCATTAGTATTCTAGTGGGCATGCCTGTTC GAGCGTCATTTCAACCCCTAAGCACAGCTTATTGTTGGGCGTC TACGTCTGTAGTGCCTCAAAGACATTGGCGGAGCGGCAGCAGT CCTCTGAGCGTAGTAATTCTTTATCTCGCTTCTGTTAGGCGCTG CCCCCCCGGCCGTAAAACCCCCAATTTTTCTGGTTGACCTCG GATCAGGTAGGAATACCCGCTGAACTTAAGCATATCAATAGG CGGAGGAAG
F37	ß-TUBULIN (BT2)	GGGTGCCGTTTTCTGGCGAGCCGGTCTCGACAGCGATGGCCAG TACGTTTTTCTCGACTACCCCTCCTGCCCTCCTCTCCCCTCCCC ATCGCACCGTCATCGCGTCGCGGTGGGGTAGAGGAAAAACAA ACAAGAGGTGATGCGATGGAGGAAGAAGAAAACCGACCACTG ACAATGCCCTTGCTACAGGTACAACGGCACCTCGGAGCTCCAG CTCGAGCGTATGAGCGTCTACTTTAACGAGGCCTCGGGCAACA AGTACGTCCCCCGTGCCGTCCTCGTCGATCTCGAGCCCGGCAC CATGGACGCTGTCCGCGCCGGTCCTTTCGGTCAGCTGTTCCGT CCCGACAACTTCGTTTTCGGCCAGTCGGGTGCTGGCAACAACT GGGCCAAGGACACATTACACTGAGGGTAA
F37	ITS (ITS1)	GGGGTCAGAAGTATCCACTCCAACCCATGTGAACATATCTCTT TGTTGCCTCGGCGCAAGCTACCCGGGACCTCGCGCCCCGGGCG GCCCGCCGGCGGACAAACCAAACTCTGTTATCTTCGTTGATTA

		TCTGAGTGTCTTATTTAATAAGTCAAAACTTTCAACAACGGAT CTCTTGGTTCTGGCATCGATGAAGAACGCAGCGAAATGCGATA AGTAATGTGAATTGCAGAATTCAGTGAATCATCGAATCTTTGA ACGCACATTGCGCCCATTAGTATTCTAGTGGGCATGCCTGTTC GAGCGTCATTTCAACCCCTAAGCACAGCTTATTGTTGGGCGTC TACGTCTGTAGTGCCTCAAAGACATTGGCGGAGCGGCAGCAGT CCTCTGAGCGTAGTAATTCTTTATCTCGCTTCTGTTAGGCGCTG CCCCCCCGGCCGTAAAACCCCCAATTTTTCTGGTTGACCTCG GATCAGGTAGGAATACCCGCTGAACTTAAGCATATCAATAGG CCGGAGGAA
F40	ITS (ITS1)	GGGGTTTCGACTTGAATCGAGCTCGGCTCGACTCTCCCACCCT CTGTGTACCTACCTCTGTTGCTTTGGCGGTGCCGCCTCCGGGCG CCCGCCAGAGGACTTCAAAACTCCAGTCAGTGAACGTCTCAGT CTGAAAAACAAGTTAATAAACTAAAACTTTCAACAACGGATCT CTTGGTTCTGGCATCGATGAAGAACGCAGCGAAATGCGATAA GTAATGTGAATTGCAGAATTCAGTGAATCATCGAATCTTTGAA CGCACATTGCGCCCCTTGGTATTCCGGGGGGCATGCCTGTTCG AGCGTCATTTCAACCCTCAAGCTCTGCTTGGTATTGGGCTCCGT CCTCCTCGGACGCGCCTCAAAGACCTCGGCGGTGGCGTCTTGC CTCAAGCGTAGTAGAAAACACCTCGCTTTGGAGCGCATGGCGT CGCCCGCCGGACGAAACCTTTTGCATTTTTCTCAAGGTTGACC TCGGATCAGGTAGGGATACCCGCTGAACTTAAGCATATCAATA GGCGGAGGAAA
F41	ITS (ITS1)	GGGGGGATCCTTTAAATATGAGGCTTCGGCTGGATTATTTTTA TCACCCTTGTCTTTTGCGCACTTGTTGTTTCCTGGGCGGGTTCG CCCGCCACCAGGACCACACCATAAACCTTTTTATGCAGTTGC AATCAGCGTCAGTATAACAAATGTAAATCATTTACAACTTTCA ACAACGGATCTCTTGGTTCTGGCATCGATGAAGAACGCAGCGA AATGCGATACGTAGTGTGAATTGCAGAATTCAGTGAATCATCG AATCTTTGAACGCACATTGCGCCCTTTGGTATTCCAAAGGGCA TGCCTGTTCGAGCGTCATTTGTACCTTCAAGCTTTGCTTGGTGT TGGGCGTCTTTTTGTCTTTGGCCTCGCCCAAAGACTCGCCTTAA AACGATTGGCAGCCGGCCTACTGGTTTCGCAGCGCAGCACATT

		TTTGCGCTTGCAATCAGCAAAAGGACGGCAATCCATCAAGA CTACATTTTTACGTTTGACCTCGGATCAGGTAGGGATACCCGC TGAACTTAAGCATATCAATAGGCCGGAGGAAAA
F41	GpDef	CAAACGCTAATGGTAGCCCGCAGCATCGAGCACAACGACGTC GAGATCGTCGCCGTAAACGACCCTTTCATTGAGCCCCACTACG CTGTAAGCATCCCCCAGTACAGACTCGTTTCGACTGTCAGAGC AATGGCCTGCATCATTTGCTTTGGCCTGACGCCCCAGCATCAT TCATTGGTAGAGCAGTATAGGCTAACATCTACATAGGCATACA TGCTCAAGTATGACAGCACACACGGCCAGTTCAAGGGCGACA TCAAGGTTGACGGCAACAACCTGACTGTTAACGGCAAGACTGT CCGCTTCCACATGGAGAAGGACCCCGCCAACATCCCATGGAG CGAGACCGGCGCCTACTACGTCGTTGAGTCCACCGGTGTCTTC ACCACTACCGAGAAGGCCAAGGCTCACTTGAAGGGTGGAGCC AAGAAGGTTGTCATCTCTGCTCCTTCCGCCGATGCTCCAATGTT CGTCATGGGTGTCAACCACGAGACCTACAAGTCCGACATTGAG GTGCTCTCCAACGACTG
F45	ITS (ITS1)	GGGGGAGCTTTGGAATTAACTCCCAAACCCATGTGACTTATCT CTTTGTTGCCTCGGCGCAAGCTACCCGGGACCTCGCGCCCCGG GGGGCCCGCCGGCGGACAAACCAAACTCTGTTATCTTCGTTGA TTATCTGAGTGTCTTATTTAATAAGTCAAAACTTTCAACAACG GATCTCTTGGTTCTGGCATCGATGAAGAACGCAGCGAAATGCG ATAAGTAATGTGAATTGCAGAATTCAGTGAATCATCGAATCTT TGAACGCACATTGCGCCCATTAGTATTCTAGTGGGCATGCCTG TTCGAGCGTCATTTCAACCCCTAAGCACAGCTTATTGTTGGGA CTCTACGGCTTCGTAGTTCCCCAAAGACATTGGCGGAGTGGCA GCAGTCCTCTGAGCGTAGTAATTCTTTATCTCGCTTTTGTTAGG CGCTGCCCCCCCGGCCGTAAAACCCCCAATTTTTTCTGGTTGA CCTCGGATCAGGTAGGAATACCCGCTGAACTTAAGCATATCAA TAAGCGGAGGAA
F46	ITS (ITS1)	AGGGGTTCAAGATTTACGGCGGGCTGGATCTCTCGGGGTTACA GCCTTGCTGAATTATTCACCCTTGTCTTTTGCGTACTTCTTGTTT CCTTGGTGGGTTCGCCCACCACTAGGACAAACATAAACCTTTT GTAATTGCAATCAGCGTCAGTAACAAATTAATAATTACAACTT

		TCAACAACGGATCTCTTGGTTCTGGCATCGATGAATAACGCAG CGAAATGCGATAAGTAGTGTGAATTGCAAAATTCAGTGAATC ATCTAATCTTTGAACGCACATTGCGCCCTTTGGTATTCCAAAG GGCATGCCTGTTCGAGCGTCATTTGGACCCTCAAGCTTTGCTT GGTGTTGGGCGTCTTGTCTCTAGCTTTGCTGGACACTCACCTTA AAGTAATTGGCAGCCGGCCTACTGGTTTCGGAGCGCAGCACA AGTCGCACTCTCTATCAGCAAAGGTCTAGCATCCATTAAGCCT TTTTTCAACTTTTGACCTCGGATCAGGTAGGGATACCCGCTGA GAATAAGCATATCAATAATCGGAGGAAGGGCTG
F47	ITS (ITS1)	GGGGGCTCCATATGATGCGGGCTGGATCTCTCGGGGTTACAGC CTTGCTGAATTATTCACCCTTGTCTTTTGCGTACTTCTTGTTTCC TTGGTGGGTTCGCCCACCACTAGGACAAACATAAACCTTTTGT AATTGCAATCAGCGTCAGTAACAAATTAATAATTACAACTTTC AACAACGGATCTCTTGGTTCTGGCATCGATGAAGAACGCAGCG AAATGCGATAAGTAGTGTGAATTGCAGAATTCAGTGAATCATC GAATCTTTGAACGCACATTGCGCCCTTTGGTATTCCAAAGGGC ATGCCTGTTCGAGCGTCATTTGTACCCTCAAGCTTTGCTTGGTG TTGGGCGTCTTGTCTCTAGCTTTGCTGGAGACTCGCCTTAAAGT AATTGGCAGCCGGCCTACTGGTTTCGGAGCGCAGCACAAGTCG CACTCTCTATCAGCAAAGGTCTAGCATCCATTAAGCCTTTTTC AACTTTTGACCTCGGATCAGGTAGGGATACCCGCTGAACTTAA GCATATCAATAGACCGGAGGA
H01	ß-TUBULIN (BT1)	AGGGGGCTCCTCATGACAGCCGTGGTGCTCACTCTTTCCGCGC TGTCAGCGTTCCTGAGCTGACCCAGCAGATGTTCGACCCCAAG AACATGATGGCTGCTTCCGACTTCCGCAACGGTCGTTACCTGA CCTGTTCTGCCATCTTCCGTGGCCGCGTCGCCATGAAGGAGGT CGAGGACCAGATGCGCAACGTTCAGAACAAGAACTCATCTTA TTTCGTCGAGTGGATCCCTAACAACATCCAGACCGCTCTCTGC GCTATTCCTCCTCGGGGACTTACTATGTCCTCTACCTTCATTGG AAACTCCACCTCTATCCAGGAGCTTTTCAAGCGTGTTGGCGAG CAGTTTACTGCTATGTTCCGACGCAAGGCTTTCTTGCATTGGTA CACTGGTGAGGGTATGGACGAGATGGAGTTCACTGAGGCTGA GTTCAACATGAACGATCTCATCA

H01	ITS (ITS1)	GGGGACTACGACTAACTCCAACCCCTGTGACATACCTATACGT TGCCTCGGCGGATCAGCCCGCGCCCCGTAAAACGGGACGGCC CGCCCGAGGACCCCTAAACTCTGTTTTTAGTGGAACTTCTGAG TAAAACAAACAAATAAATCAAAACTTTCAACAACGGATCTCTT GGTTCTGGCATCGATGAAGAACGCAGCAAAATGCGATAAGTA ATGTGAATTGCAGAATTCAGTGAATCATCGAATCTTTGAACGC ACATTGCGCCCGCCAGTATTCTGGCGGGCATGCCTGTTCGAGC GTCATTTCAACCCTCAAGCTCAGCTTGGTGTTGGGACTCGCGG TAACCCGCGTTCCCCAAATCGATTGGCGGTCACGTCGAGCTTC CATAGCGTAGTAATCATACACCTCGTTACTGGTAATCGTCGCG GCCACGCCGTTAAACCCCAACTTCTGAATGTTGACCTCGGATC AGGTAGGAATACCCGCTGAACTTAAGCATATCAATAAGGCGG AGTAAAA
H03	ß-TUBULIN (BT1)	GACGGATCCATCTAGCCGATCACAGTGGTGCTCCTCTTGCCGC GCGGGCGTTTTCCTGAGTTGACCAGTCAGATGTTAGACACCAA ACAAATGATGGCCGCTTCGGACTTCCGCAACGGTCGCTACCTG ACCTGCTCGGCCATTTTGTGAGTGAACCCGATTTTGCACATAG AAATTACTTGCTAACTTTATACAGCCGTGGCCGTGTCGCTATG AAGGAGGTCGAGGACAAGATGCGCAACGTCCAGAACAAGAAC TCTTCTTACTTCGTTGAATGGATTCCCAACAACATCCAAACAG CCCTTTGTGCCATCCCTCCCCGAGGACTTACGATGTCCTCGACC TTCATCGGAAACTCCACCTCTATCCAGGAGCTCTTCAAGCGTG TTGGTGAGCAGTTCACTGCCATGTTCCGACGCAAGGCTTTCTT GCTTTGGTATACTGGTGAGGGTATAGACGAGATGGATTTCACT GAGGCCGAGCTCACCCAAAAACAATCTCATCA
H03	ITS (ITS1)	TGGGCTTCGGGAGTAACTCCAACCCCTGTGACATACCACTTGT TGCCTCGGCGGATCAGCCCGCTCCCGGTAAAACGGGACGGCC CGCCAGAGGACCACTAAACTCTGTTTCTATATGTAACTTCTGA GTAAAACCATAAATAAATCAAAACTTTCAACAACGGATCTCTT GGTTCTGGCATCGATGAAGAACGCAGCAAAATGCGATAAGTA ATGTGAATTGCAGAATTCAGTGAATCATCGAATCTTTGAACGC ACATTGCGCCCGCCAGTATTCTGGCGGGCATGCCTGTTCGAGC GTCATTTCAACCCTCAAGCACAGCTTGGTGTTGGGACTCGCGT

		TAATTCGCGTTCCCCAAATTGATTGGCGGTCACGTCGAGCTTC CATAGCGTAGTAGTAAAACCCTCGTTACTGGTAATCGTCGCGG CCACGCCGTTAAACCCCAACTTCTGAATGTTGACCTCGGATCA GGTAGGAATACCCGCTGAACTTAAGCATATCAATAGGCGGAG GATA
H04	ß-TUBULIN (BT2)	GAGGAATCTCTGGCGAGCCGGTCTCGACAGCAATGGTGTTTAC AACGGTACCTCCGAGCTCCAGCTCGAGCGTATGAGCGTCTACT TCAACGAGGTATGTTTCATCACTCCTGCCACAAAAACACAACA AGCTCACGCGCGCCTAGGCTTCCGGTAACAAGTATGTTCCCCG TGCCGTCCTCGTCGATCTCGAGCCCGGTACCATGGACGCCGTC CGTGCCGGTCCTTTCGGACAGCTTTTCCGTCCCGACAACTTCGT TTTCGGTCAATCCGGTGCCGGAAACAACTGGGCCAAGGGTCAC TACACTGAGGGTA
H04	TEF (EF1)	AGTTTCAAATTGAATATCTGCTGACAAGATTGCATAAACCGGT CACTTGATCTACCAGTGAGGTGGTATCGACAAGCGAACCATCG AGAAGTTCGAGAAGGTTGGTTTCCATTTTCCTCGATCGCACGC CATTCACCCACCGATCCATCACACGAACCAGTCTTACGACAAC TGAATATGCGCCTGTTACCCCGCTCGAGTACAAAAATTTGCGG TTCAACCGCATTTTTTTGGTGGGGGTTGAACC
H04	ITS (ITS1)	TGGGCTACGAGTTAACTCCCAACCCCTGTGACATACCTATACG TTGCCTCGGCGGATCAGCCCGCGCCCCGTAAAACGGGACGGC CCGCCCGAGGACCCTAAACTCTGTTTTTAGTGGAACTTCTGAG TAAAACAAACAAATAAATCAAAACTTTCAACAACGGATCTCTT GGTTCTGGCATCGATGAAGAACGCAGCAAAATGCGATAAGTA ATGTGAATTGCAGAATTCAGTGAATCATCGAATCTTTGAACGC ACATTGCGCCCGCCAGTATTCTGGCGGGCATGCCTGTTCGAGC GTCATTTCAACCCTCAAGCTCAGCTTGGTGTTGGGACTCGCGG TAACCCGCGTTCCCCAAATCGATTGGCGGTCACGTCGAGCTTC CATAGCGTAGTAATCATACACCTCGTTACTGGTAATCGTCGCG GCCACGCCGTTAAACCCCAACTTCTGAATGTTGACCTCGGATC AGGTAGGAATACCCGCTGAACTTAAGCAAATCAATAGGCGGA GGAATA

H05	ß-TUBULIN (BT2)	GGGGCTCTCTGGCGAGCCGGTCTCGACAGCAATGGTGTTTACAACGGTACCTCCGAGCTCCAGCTCGAGCGTATGAGCGTCTACTTCAACGAGGTTTGTTTCATCACTCCTGCCACGAAAACACAACAAGCTCACGCGCGCCTAGGCTTCCGGTAACAAGTATGTTCCCCGTGCCGTCCTCGTCGATCTCGAGCCCGGTACCATGGACGCCGTCCGTGCCGGTCCTTTCGGACAGCTTTTCCGTCCCGACAACTTCGTTTTCGGTCAATCCGGTGCCGGAAACAACTGGGCCAAGGGTCACTACACTGAGGGTTACACGGGACGTGAAGAACTCATTATGATCAACCGAATTCTCCGAGACGATCCGGCCAAGGGTCACTACACTGAGGGTCA
H05	TEF (EF1)	GCAGTCATCAACCCCGCCAGATGTGGCGGGGTAATTTCAACTTGAATATTTGCTGACAAGATTGCATAGACCGGTCACTTGATCTACCAGTGCGGTGGTATCGACAAGCGAACCATCGAGAAGTTCGAGAAGGTTGGTTTCCATTTCCCCGATCGCACGCCGTCTACCCACCGATCCATCAGTCGAATCAGTTACGACGATTGAATATGCGCCTGTTACCCCGCTCGAGTACAAAATTTTGCGGTTCAACCGTAATTTTTTTGGTGGGGTTTCAACCCCGCTACTCGAGCGACAGACGTTTGCCCTCTTCCCACAAACTCATGTCTCGTGCATCACGTGTCCATCAGCCACTAACCACCCGACAATAGGAAGCCGCCGAGCTCGGTAAGGGTTCCTTCAAGTACGCCTGGGTTCTTGACAAGCTCAAGGCTGAGCGTGAGCGTGGTATCACCATCGATATCGCCCTCTGGAAGTTCGAGACTCCTCGCTACTATGTCACCGTCATTGGTACGTTATCATCAC
H05	ITS (ITS1)	GGGGGATCGGGGCTTCACTCCAAACCCCTGTGACATACCTATACGTTGCCTCGGCGGATCAGCCCGCGCCCCGTAAAACGGGACGGCCCGCCCGAGGACCCCTAAACTCTGTTTTTAGTGGAACTTCTGAGTAAAACAAACAAATAAATCAAAACTTTCAACAACGGATCTCTTGGTTCTGGCATCGATGAAGAACGCAGCAAAATGCGATAAGTAATGTGAATTGCAGAATTCAGTGAATCATCGAATCTTTGAACGCACATTGCGCCCGCCAGTATTCTGGCGGGCATGCCTGTTCGAGCGTCATTTCAACCCTCAAGCTCAGCTTGGTGTTGGGACTCGCGGTAACCCGCGTTCCCCAAATCGATTGGCGGTCACGTCGAGCTTCCATAGCGTAGTAATCATACACCTCGTTACTGGTAATCGTC

		GCGGCCACGCCGTTAAACCCCAACTTCTGAATGTTGACCTCGGATCAGGTAGGAATACCCGCTGAACTTAAGCATAACAAAAGGCGGAGGAT
H09	TEF (EF1)	ACTCTGGCAGTCGACCACTGTGAGTACTACCCACGATGATTTGCTTATCAGCAGTCATCAACCCCGCCAGATGTGGAGGGGTAATTTCAACTTGAATATTTGCTGACAAGATTGCATAGACCGGTCACTTGATCTACCAGTGCGGTGGTATCGACAAGCGAACCATCGAGAAGTTCGAGAAGGTTGGTTTCCATTTCCCCGATCGCACGCCGTCTACCCACCGATCCATCAGTCGAATCAGTTACGACGATTGAATATGCGCCTGTTACCCCGCTCGAGTACAAAATTTTGCGGTTCAACCGTAATTTTTTTGGTGGGGTTTCAACCCCGCTACTCGAGCGACAGACGTTTGCCCTCTTCCCACAAACTCATGTCTCGTGCATCACGTGTCCATCAGCCACTAACCACCCGACAATAGGAAGCCGCCGAGCTCGGTAAGGGTTCCTTCAAGTACGCCTGGGTTCTTGACAAGCTCAAGGCTGAGCGTGAGCGTGGTATCACCATCGATATCGCCCTCTGGAAGTTCGAGACTCCTCGCTACTATGTCACCGTCATTGGTACGTTATCATCACTTACACTCAATACTTTCTCATGCTAACATGTACTTCAGACGCTCCCCGGTCACCGTGATTTCCTCAAA
H13	ß-TUBULIN (BT1)	GAGGTTTTGCTCTCTGACAGCCGTGGTGCTCACTCTTTCCGCGCTGTCAGCGTTCCTGAGTTGACCCAACAGATGTTCGACCCCAAGAACATGATGGCTGCTTCGGACTTCCGCAATGGTCGCTACCTGACCTGCTCGGCCATTTTGTGAGTGAACCCGATTTTACACACGGAAATTATTTACTGACTTTGCACAGCCGTGGCCGTGTCGCTATGAAGGAGGTCGAGGATCAGATGCGCAACGTCCAGAGCAAGAACTCTTCTTACTTCGTTGAATGGATTCCCAACAACATCCAGACAGCCCTTTGTGCCATCCCTCCCCGAGGACTTACGATGTCTTCGACCTTCATCGGAAACTCCACTTCTATTCAGGAGCTCTTCAAGCGTGTCGGTGAGCAGTTCACTGCCATGTTCCGACGCAAGGCTTTCTTGCATTGGTATACTGGTGAGGGTATGGACGAGATGGAGTTCACTGAGGCTGAGTTCAACATGAACGATCTCATCA
H13	ITS (ITS1)	GGGGGGAACGAGCTAAACTCCAACCCCTGTGACATACCAATTGTTGCCTCGGCGGATCAGCCCGCTCCCGGTAAAACGGGACGGCCCGCCAGAGGACCCCTAAACTCTGTTTCTATATGTAACTTCT

		GAGTAAAACCATAAATAAATCAAAACTTTCAACAACGGATCT CTTGGTTCTGGCATCGATGAAGAACGCAGCAAAATGCGATAA GTAATGTGAATTGCAGAATTCAGTGAATCATCGAATCTTTGAA CGCACATTGCGCCCGCCAGTATTCTGGCGGGCATGCCTGTTCG AGCGTCATTTCAACCCTCAAGCCCCCGGGTTTGGTGTTGGGGA TCGGCGAGCCTCACGGCAAGCCGGCCCCGAAATACAGTGGCG GTCTCGCTGCAGCTTCCATTGCGTAGTAGTAAAACCCTCGCAA CTGGTACGCGGCGCGGCCAAGCCGTTAAACCCCCAACTTCTGA ATGTTGACCTCGGATCAGGTAGGAATACCCGCTGAACTTAAGA AGTATCAATAAGCGGAGGA
H16	ITS (ITS1)	GGGGGCTCGGACTCACTCCAACCCCTGTGACATACCAATTGTT GCCTCGGCGGATCAGCCCGCTCCCGGTAAAACGGGACGGCCC GCCAGAGGACCCCTAAACTCTGTTTCTATATGTAACTTCTGAG TAAAACCATAAATAAATCAAAACTTTCAACAACGGATCTCTTG GTTCTGGCATCGATGAAGAACGCAGCAAAATGCGATAAGTAA TGTGAATTGCAGAATTCAGTGAATCATCGAATCTTTGAACGCA CATTGCGCCCGCCAGTATTCTGGCGGGCATGCCTGTTCGAGCG TCATTTCAACCCTCAAGCCCAGCTTGGTGTTGGGACTCGCGAG TCAAATCGCGTTCCCCAAATTGATTGGCGGTCACGTCGAGCTT CCATAGCGTAGTAGTAAAACCCTCGTTACTGGTAATCGTCGCG GCCACGCCGTTAAACCCCAACTTCTGAATGTTGACCTCGGATC AGGTAGGAATACCCGCTGAACTTAAGCATATCAATAGGCGGA GGAACT
H17	ITS (ITS1)	GGGGATCGGGCTAACTCCAACCCCTGTGACATACCAATTGTTG CCTCGGCGGATCAGCCCGCTCCCGGTAAAACGGGACGGCCCG CCAGAGGACCCCCAAACTCTGTTTCTATATGTAACTTCTGAGT AAAACCATAAATAAATCAAAACTTTCAACAACGGATCTCTTGG TTCTGGCATCGATGAAGAACGCAGCAAAATGCGATAAGTAAT GTGAATTGCAGAATTCAGTGAATCATCGAATCTTTGAACGCAC ATTGCGCCCGCCAGTATTCTGGCGGGCATGCCTGTTCGAGCGT CATTTCAACCCTCAAGCCCAGCTTGGTGTTGGGACTCGCGAGT CAAATCGCGTTCCCCAAATTGATTGGCGGTCACGTCGAGCTTC CATAGCGTAGTAGTAAAACCCTCGTTACTGGTAATCGTCGCGG

		CCACGCCGTTAAACCCCAACTTCTGAATGTTGACCTCGGATCA GGTAGGAATACCCGCTGAACTTAAGCATATCAATAAGGCGGA GGTAC
H28	ApMat (AMf)	CAGACCTAGTTATTCACGTGATGCGCAGTCGAGACAGTGGCTG GGCATCATGGATGTGTTGGCAGTCTGCAGTGGCGAAGAGCAA CGTGTGGGCGAATCAATGGTCCTCATGGCGGGGGGTAAAAGA CACTCTAGGTATCGGGCTGGAATATATGTTCCATGAAGAGGAT AC
H30	ApMat (AMf)	CACCTAGTTATTCCGTGATGCGCAGTCGAGACAGTGGCTGGGC ATCATGGATGTGTTGGCAGTCTGCAGTGGCGAAGAGCAACGT GTGGGCGAATCAATGGTCCTCATGGCGGGGGGTAAAAGACAC TCTAGGTATCGGGCTGGAATAGATGTTCCATGAAGAGGATATT TACTGGCTTGCAGATTGTAATTACAGAAAAAGATTCGTGTTCG CTTGACATGCGAATACATGGGTTGTGAGTACATTTTTCCACCA ATATGGTCATCAAATCGAAGATCTCTGCTTCGCGTTGCCATCG AAGCAGATGGTCCAGGATGATTCTTGGTTCCTCAGATCCGGTG ATCTCCTAGCG
I15	ITS (ITS1)	GGGGCATCGGACTCACTCCAAACCCCTGTGACATACCAATTGT TGCCTCGGCGGATCAGCCCGCTCCCGGTAAAACGGACGGCC CGCCAGAGGACCCCTAAACTCTGTTTCTATATGTAACTTCTGA GTAAAACCATAAATAAATCAAAACTTTCAACAACGGATCTCTT GGTTCTGGCATCGATGAAGAACGCAGCAAAATGCGATAAGTA ATGTGAATTGCAGAATTCAGTGAATCATCGAATCTTTGAACGC ACATTGCGCCCGCCAGTATTCTGGCGGGCATGCCTGTTCGAGC GTCATTTCAACCCTCAAGCCCAGCTTGGTGTTGGGACTCGCGA GTCAAATCGCGTTCCCCAAATTGATTGGCGGTCACGTCGAGCT TCCATAGCGTAGTAGTAAAACCCTCGTTACTGGTAATCGTCGC GGCCACGCCGTTAAACCCCAACTTCTGAATGTTGACCTCGGAT CAGGTAGGAATACCCGCTGAACTTAAGCATATCAATAGGCGG AGGAATA
I20	ß-TUBUL	GGAGTAATCTTGTACGTGTTCGTTCATGAATGCTCGCTATCGG CCGCGCCGTCAGCGTTCCTGAGCTGACCCAGCAGATGTTCGAC

	IN (BT1)	CCCAAGAACATGATGGCTGCTTCCGACTTCCGCAACGGTCGTTACCTGACCTGCTCTGCCATCTTCCGTGGCCGCGTCGCCATGAAGGAGGTCGAGGACCAGATGCGCAACGTTCAGAACAAGAACTCATCTTACTTCGTCGAGTGGATTCCTAACAACATCCAGACCGCTCTCTGCGCTATTCCTCCTCGGGGACTTACTATGTCCTCTACCTTTATTGGAAACTCCACCTCTATCCAGGAGCTTTTCAAGCGTGTTGGCGAGCAGTTCACTGCTATGTTCCGACGCAAGGCTTTCTTGCATTGGTACACTGGTGAGGGTATGGACGAGATGGAGTTCACTGAGGCTGAGTTCAACAAGAACGATCTCATCC
I20	ITS (ITS1)	GGGGGGAACGAGCTTCACTCCAACCCCTGTGACATACCTATACGTTGCCTCGGCGGATCAGCCCGCGCCCTGTAAAACGGGACGGCCCGCCCGAGGACCCTAAACTCTGTTTTTAGTGGAACTTCTGAGTAAAACAAACAAATAAATCAAAACTTTCAACAACGGATCTCTTGGTTCTGGCATCGATGAAGAACGCAGCAAAATGCGATAAGTAATGTGAATTGCAGAATTCAGTGAATCATCGAATCTTTGAACGCACATTGCGCCCGCCAGTATTCTGGCGGGCATGCCTGTTCGAGCGTCATTTCAACCCTCAAGCTCAGCTTGGTGTTGGGACTCGCGGTAACCCGCGTTCCCCAAATCGATTGGCGGTCACGTCGAGCTTCCATAGCGTAGTAATCATACACCTCGTTACTGGTAATCGTCGCGGCCACGCCGTTAAACCCCAACTTCTGAATGTTGACCTCGGATCAGGTAGGAATACCCGCTGAACTTAAGCATATCAATAAGGCGGAGGAAA
I21	ß-TUBULIN (BT2)	GATGTAATCTCTGGCGAGCCGGTCTCGACAGCAATGGTGTTTACAACGGTACCTCCGAGCTCCAGCTCGAGCGTATGAGCGTCTACTTCAACGAGGTTTGTTTCATCACTCCTGCCACGAAAACACAACAAGCTCACGCGCGCCTAGGCTTCCGGTAACAAGTATGTTCCCCGTGCCGTCCTTGTCGATCTCGAGCCCGGTACCATGGACGCCGTCCGTGCCGGTCCTTTCGGACAGCTCTTCCGTCCCGACAACTTCGTTTTCGGTCAATCCGGTGCCGGAAACAACTGGGCCAAGGGTCACTACACTGAGGGTA
I21	ß-TUBULIN	GGGCTCCTCCTCCATGACAGCCGTGGTGCTCACTCTTTCCGCGCCGTCAGCGTTCCTGAGCTGACCCAGCAGATGTTCGACCCCAAGAACATGATGGCTGCTTCCGACTTCCGCAACGGTCGTTACCTG

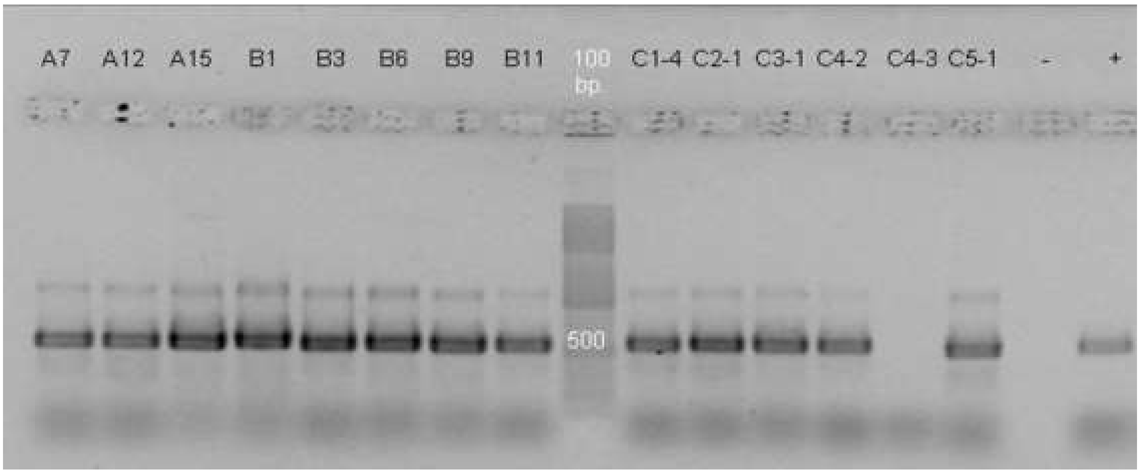
	(BT1)	ACCTGCTCTGCCATCTTCCGTGGCCGCGTCGCCATGAAGGAGG TCGAGGACCAGATGCGCAACGTTCAGAACAAGAACTCATCTT ACTTCGTCGAGTGGATTCCTAACAACATCCAGACCGCTCTCTG CGCTATTCCTCCTCGGGGACTTACTATGTCCTCTACCTTTATTG GAAACTCCACCTCTATCCAGGAGCTTTTCAAGCGTGTTGGCGA GCAGTTCACTGCTATGTTCCGACGCAAGGCTTTCTTGCATTGGT ACACTGGTGAGGGTATGGACGAGATGGAGTTCACTGAGGCTG AGTTCAACATGAACAAATCTCATCA
I21	ITS (ITS1)	TGGGGAAAGGGGCTCACTCCAACCCCTGTGACATACCTATACG TTGCCTCGGCGGATCAGCCCGCGCCCTGTAAAACGGGACGGCC CGCCCGAGGACCCTAAACTCTGTTTTTAGTGGAACTTCTGAGT AAAACAAACAAATAAATCAAAACTTTCAACAACGGATCTCTT GGTTCTGGCATCGATGAAGAACGCAGCAAAATGCGATAAGTA ATGTGAATTGCAGAATTCAGTGAATCATCGAATCTTTGAACGC ACATTGCGCCCGCCAGTATTCTGGCGGGCATGCCTGTTCGAGC GTCATTTCAACCCTCAAGCTCAGCTTGGTGTTGGGACTCGCGG TAACCCGCGTTCCCCAAATCGATTGGCGGTCACGTCGAGCTTC CATAGCGTAGTAATCATACACCTCGTTACTGGTAATCGTCGCG GCCACGCCGTTAAACCCCAACTTCTGAATGTTGACCTCGGATC AGGTAGGAATACCCGCTGAACTTAAGCATATCAATAGGCGGA GGAAC
I22	ß- TUBUL IN (BT2)	GCGTCTCTCTGGCGAGCCGGTCTCGACAGCAATGGTGTTTACA ACGGTACCTCCGAGCTCCAGCTCGAGCGTATGAGCGTCTACTT CAACGAGGTTTGTTTCATCACTCCTGCCACGAAAACATAATAA GCTCACGCGCGCCTAGGCTTCTGGTAACAAGTATGTTCCCCGT GCCGTCCTCGTCGATCTCGAGCCCGGTACCATGGACGCCGTCC GTGCCGGTCCTTTCGGACAGCTTTTCCGTCCCGACAACTTCGTT TTCGGTCAATCCGGTGCCGGAAACAACTGGGCCAAGGGTCAA TACACTGAGGGTA
I22	ß- TUBUL IN	AGGCTTCTCTCATGAAGCCGTGGTGCTCACTCTTTCCGCGCTGT CAGCGTTCCTGAGCTGACCCAGCAGATGTTCGACCCCAAGAAC ATGATGGCTGCTTCCGACTTCCGCAACGGTCGTTACCTGACCT GCTCTGCCATCTTCCGGGGCCGCGTCGCCATGAAGGAGGTCGA

	(BT1)	GGACCAGATGCGCAACGTTCAGAACAAGAACTCATCTTACTTC GTCGAGTGGATCCCTAACAACATCCAGACCGCTCTCTGCGCTA TTCCTCCTCGGGGACTTACTATGTCCTCTACCTTTATTGGAAAC TCCACCTCTATCCAGGAGCTTTTCAAGCGTGTTGGCGAGCAGT TCACTGCTATGTTCCGACGCAAGGCTTTCTTGCATTGGTACACT GGTGAGGGTATGGACGAGATGGAGTTCACTGAGGCTGAGTTC AACATAAACGATCTCATCA
I22	ITS (ITS1)	GGGGGAATCGGGCTAACTCCAACCCCTGTGACATACCTATACG TTGCCTCGGCGGATCAGCCCGCGCCCTGTAAAAGGGACGGC CCGCCCGAGGACCCTAAACTCTGTTTTAGTGGAACTTCTGAG TAAAACAAACAAATAAATCAAAACTTTCAACAACGGATCTCTT GGTTCTGGCATCGATGAAGAACGCAGCAAAATGCGATAAGTA ATGTGAATTGCAGAATTCAGTGAATCATCGAATCTTTGAACGC ACATTGCGCCCGCCAGTATTCTGGCGGGCATGCCTGTTCGAGC GTCATTTCAACCCTCAAGCTCAGCTTGGTGTTGGGACTCGCGG TAACCCGCGTTCCCCAAATCGATTGGCGGTCACGTCGAGCTTC CATAGCGTAGTAATCATACACCTCGTTACTGGTAATCGTCGCG GCCACGCCGTAAAACCCCAACTTCTGAATGTTGACCTCGGATC AGGTAGGAATACCCGCTGAACTTAAGCATATCAATAAGGCGG AGGAAA
I23	ß-TUBULIN (BT1)	GAGGTCTTCATTCATGACGCCGTGGTGCTCACTCTTTCCGCGCT GTCAGCGTTCCTGAGCTAACCCAGCAGATGTTCGACCCCAAGA ACATGATGGCTGCTTCCGACTTCCGCAACGGTCGTTACCTGAC CTGCTCTGCCATCTTCCGTGGCCGCGTCGCCATGAAGGAGGTC GAGGACCAGATGCGCAACGTTCAGAACAAGAACTCATCTTAC TTCGTCGAGTGGATCCCTAACAACATCCAGACCGCTCTCTGCG CTATTCCTCCTCGGGGACTTACTATGTCCTCTACCTTTATTGGA AACTCCACCTCTATCCAGGAGCTTTTCAAGCGTGTTGGCGAGC AGTTTACTGCTATGTTCCGACGCAAGGCTTTCTTGCATTGGTAC ACTGGTGAGGGTATGGACGAGATGGAGTTCACTGAGGCTGAG TTCAACATAAACGATCTCATCA
I23	ITS	TTGGGATCGGGCTAACTCCAACCCCTGTGACATACCTATACGT TGCCTCGGCGGATCAGCCCGCGCCCCGTAAAACGGGACGGCC

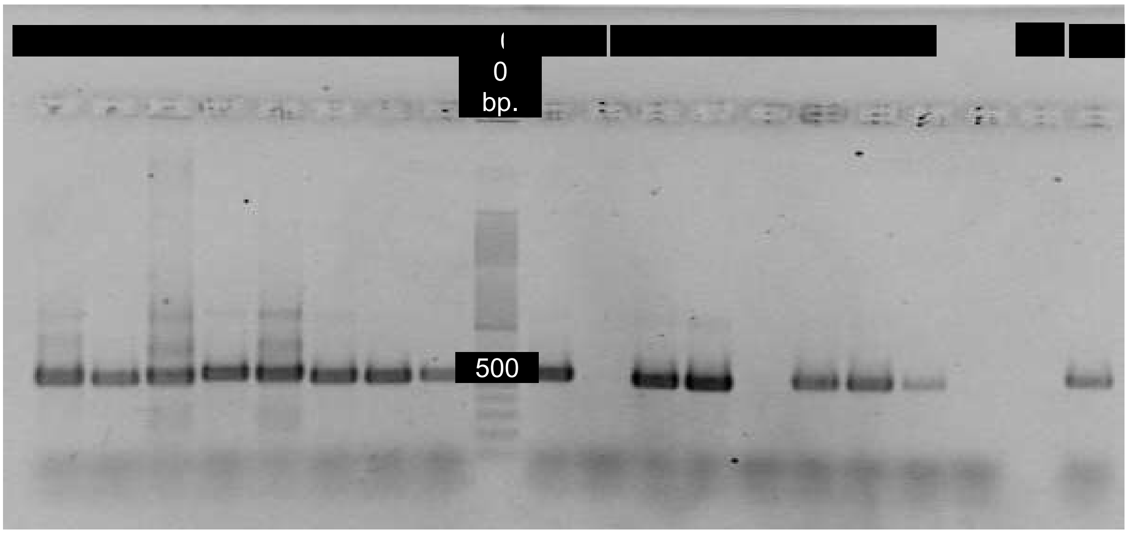
	(ITS1)	CGCCCGAGGACCCTAAACTCTGTTTTTAGTGGAACTTCTGAGT AAAACAAACAAATAAATCAAAACTTTCAACAACGGATCTCTT GGTTCTGGCATCGATGAAGAACGCAGCAAAATGCGATAAGTA ATGTGAATTGCAGAATTCAGTGAATCATCGAATCTTTGAACGC ACATTGCGCCCGCCAGTATTCTGGCGGGCATGCCTGTTCGAGC GTCATTTCAACCCTCAAGCTCAGCTTGGTGTTGGGACTCGCGG TAACCCGCGTTCCCCAAATCGATTGGCGGTCACGTCGAGCTTC CATAGCGTAGTAATCATACACCTCGTTACTGGTAATCGTCGCG GCCACGCCGTAAAACCCCAACTTCTGAATGTTGACCTCGGATC AGGTAGGAATACCCGCTGAACTTAAGCAGATCAATAGACGGA GGAT
I24	ß-TUBULIN (BT2)	GAGTTCTCTCTGGCGAGCCGGTCTCGACAGCAATGGTGTTTAC AACGGTACCTCCGAGCTCCAGCTCGAGCGTATGAGCGTCTACT TCAACGAGGTTTGCTTCATCACTCCTGCCACGAAAACACAACA AGCTCACGCGCGCCTAGGCTTCTGGTAACAAGTATGTTCCCCG TGCCGTCCTCGTCGATCTCGAGCCCGGTACCATGGACGCCGTC CGTGCCGGTCCTTTCGGACAGCTTTTCCGTCCCGACAACTTCGT TTTCGGTCAATCCGGTGCCGGAAACAACTGGGCCAAGGGTCAC AACACTGAGGGT
I24	TEF (EF1)	ACATCAACCCCGCCAGATGTGGCGGGGTAATTTCAACTTGAAT ATTTGCTGACAAGATTGCATAGACCGGTCACTTGATCTACCAG TGCGGTGGTATCGACAAGCGAACCATCGAGAAGTTCGAGAAG GTTGGTTTCCATTCCCCCGATCGCACGCCCTCTACCCACCGATC CATCAGTCGAATCAGTTACGACGATTGAATATGCGCCTGTTAC CCCGCTCGAGTACAAAATTTTGCGGTTCAACCGTATTTTTTTGG TGGGGTTTCAACCCCGCTACTCGAGCGACAGACGTTTGCCCTC TTCCCACAAACTCA
I24	ITS (ITS1)	GGGGGCCACGGACTCACTCCAACCCCTGTGACATACCTATACG TTGCCTCGGCGGATCAGCCCGCGCCCCGTAAAACGGGACGGC CCGCCCGAGGACCCCTAAACTCTGTTTTTAGTGGAACTTCTGA GTAAAACAAACAAATAAATCAAAACTTTCAACAACGGATCTC TTGGTTCTGGCATCGATGAAGAACGCAGCAAAATGCGATAAG TAATGTGAATTGCAGAATTCAGTGAATCATCGAATCTTTGAAC

		GCACATTGCGCCCGCCAGTATTCTGGCGGGCATGCCTGTTCGA GCGTCATTTCAACCCTCAAGCTCAGCTTGGTGTTGGGACTCGC GGTAACCCGCGTTCCCCAAATCGATTGGCGGTCACGTCGAGCT TCCATAGCGTAGTAATCATACACCTCGTTACTGGTAATCGTCG CGGCCACGCCGTAAAACCCCAACTTCTGAATGTTGACCTCGGA TCAGGTAGGAATACCCGCTGAACTTAAGCATATCAATAAGCG GAGGAA
I28	ß- TUBUL IN (BT2)	GGGGACTCTCTGGCGAGCCGGTCTCGACAGCAATGGTGTTTAC AACGGTACCTCCGAGCTCCAGCTCGAGCGTATGAGCGTCTACT TCAACGAGGTTTGTTTCATCACTCCTGCCACGAAAACACAACA AGCTCACGCGCGCCTAGGCTTCCGGTAACAAGTATGTTCCCCG TGCCGTCCTCGTCGATCTCGAGCCCGGTACCATGGACGCCGTC CGTGCCGGTCCTTTCGGACAGCTTTTCCGTCCCGACAACTTCGT TTTCGGTCAATCCGGTGCCGGAAACAACTGGGCCAAGGGTCAC AACACTGAGGGTA
I28	ß- TUBUL IN (BT1)	GAGGCCCTCCTCATGACGCCGTGGTGCTCACTCTTTCCGCGCT GTCAGCGTTCCTGAGCTGACCCAGCAGATGTTCGACCCCAAGA ACATGATGGCTGCTTCCGACTTCCGCAACGGTCGTTACCTGAC CTGTTCTGCCATCTTCCGTGGCCGCGTCGCCATGAAGGAGGTC GAGGACCAGATGCGCAACGTTCAGAACAAGAACTCATCTTAC TTCGTCGAGTGGATCCCTAACAACATCCAGACCGCTCTCTGCG CTATTCCTCCTCGGGGACTTACTATGTCCTCTACCTTTATTGGA AACTCCACCTCTATCCAGGAGCTTTTCAAGCGTGTTGGCGAGC AGTTTACTGCTATGTTCCGACGCAAGGCTTTCTTGCATTGGTAC ACTGGTGAGGGTATGGACGAGATGGAGTTCACTGAGGCTGAG TTCAACATGAACGATCTCGTCA
I28	TEF (EF1)	AACTAGAATATTTGCTGACAAGATTGCATAGACCGGTCACTTG ATCTACCAGTGCGGTGGTATCGACAAGCGAACCATCGAGAAG TTCGAGAAGGTTGGTTTCCATTTCCCCGATCGCACGCCGTCTA CCCACCGATCCATCAGTCGAATCAGTTACGACGATTGAATATG CGCCTGTTACCCCGCTCGAGTACAAAATTTTGCGGTTCAACCG TAATTTTTTTTGGTGGGGTTTCAACCCCGCTACTCGAGCGACCG ACGTTTGCCCTCTTCCCACAAACTCATGTCTCGTGCATCACGTG

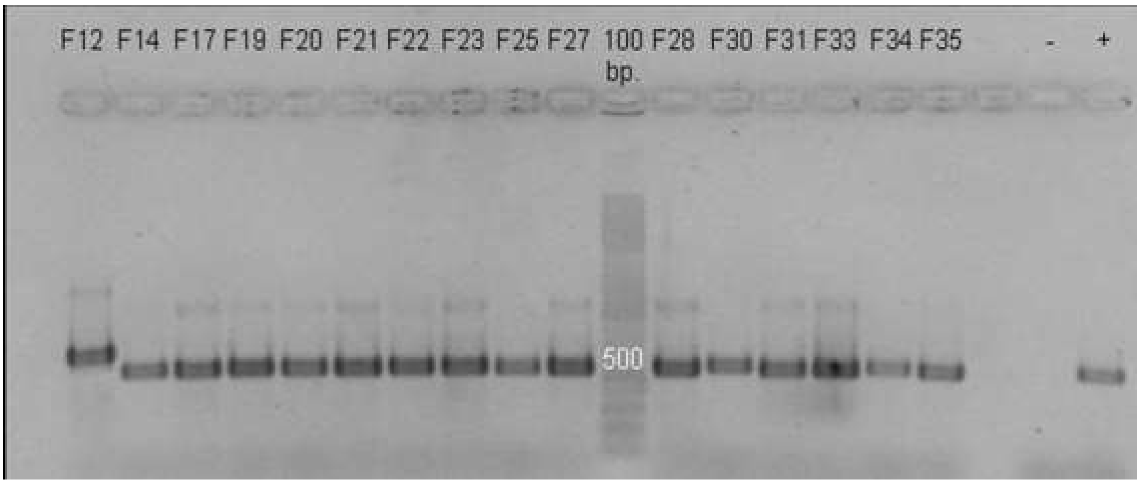
		TCCATCAGCCACTAACCACCCGACAATAGGAAGCCGCCGAGC TCGGTAAGGGTTCCTTCAAGTACGCCTGGGTTCTTGACAAGCT CAAGGCTGAGCGTGAGCGTGGTATCACCATCGATATCGCCCTC TGGAAGTTCGAGACTCCTCGCTACTATGTCACCGTCATTGGTA CGTTATCATCACTTACACTCAATACTTTCTCATGCTAACATGTA CTTCAGACGCTCCCGGTCACCGT
I28	ITS (ITS1)	GGGGGACTACCGGGCTCACTCCAACCCCTGTGACATACCTATA CGTTGCCTCGGCGGATCAGCCCGCGCCCCGTAAAACGGGACG GCCCGCCCGAGGACCCCTAAACTCTGTTTTTAGTGGAACTTCT GAGTAAAACAAACAAATAAATCAAAACTTTCAACAACGGATC TCTTGGTTCTGGCATCGATGAAGAACGCAGCAAAATGCGATAA GTAATGTGAATTGCAGAATTCAGTGAATCATCGAATCTTTGAA CGCACATTGCGCCCGCCAGTATTCTGGCGGGCATGCCTGTTCG AGCGTCATTTCAACCCTCAAGCTCAGCTTGGTGTTGGGACTCG CGGTAACCCGCGTTCCCCAAATCGATTGGCGGTCACGTCGAGC TTCCATAGCGTAGTAATCATACACCTCGTTACTGGTAATCGTC GCGGCCACGCCGTTAAACCCCAACTTCTGAATGTTGACCTCGG ATCAGGTAGGAATACCCGCTGAACTTAAGCATATCAATAAGG CGGAAGAAT



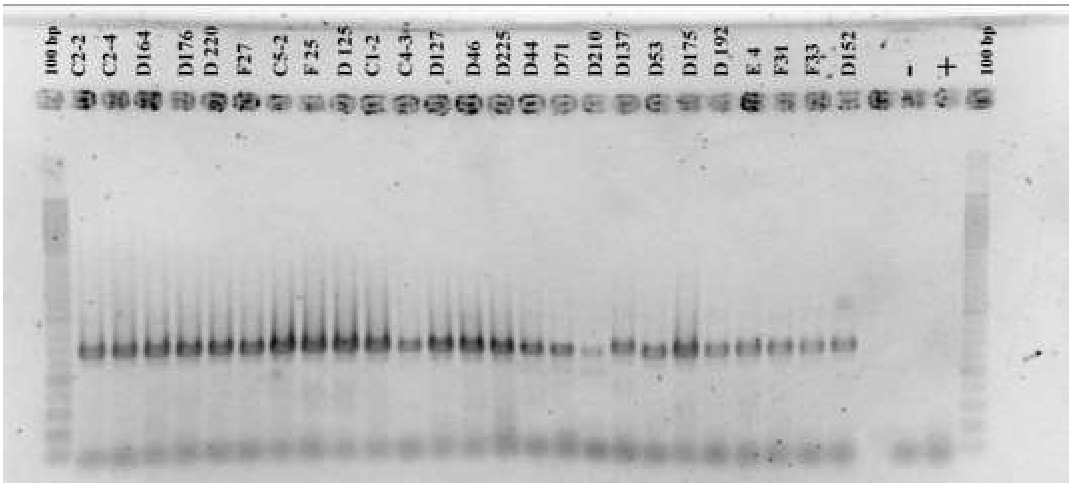
Annex B-1. Electrophoretic gel image of some amplification products obtained with ITS primer.



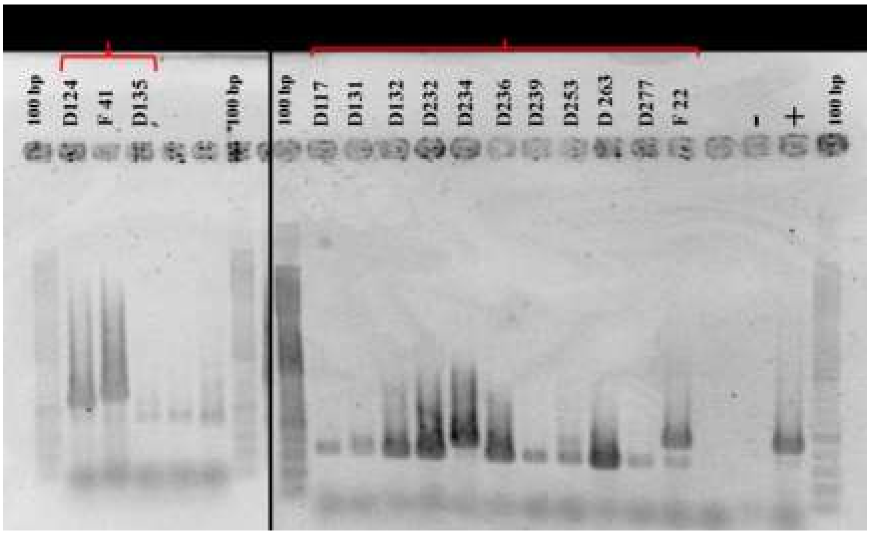
Annex B-2. Electrophoretic gel image of some amplification products obtained with ITS primer.



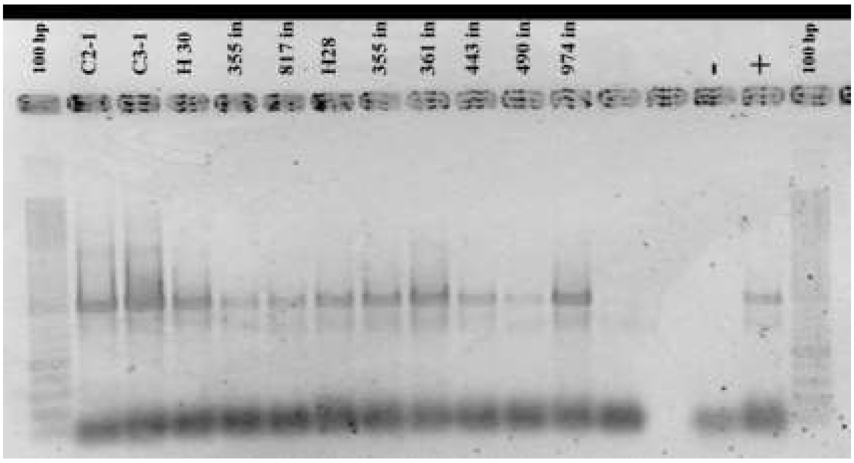
Annex B-3. Electrophoretic gel image of some amplification products obtained with ITS primer.



Annex B-4. Electrophoretic gel image of some amplification products obtained with TEF primer.



Annex B-5. Electrophoretic gel image of some amplification products obtained with GPDef and BT2a primers.



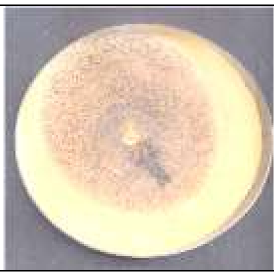
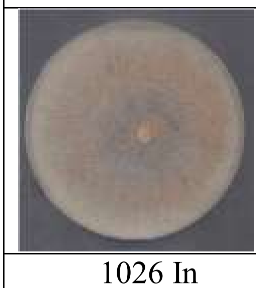
Annex B-6. Electrophoretic gel image of some amplification products obtained with ApMat primer.

			
C3-1	C4-2	D48	D128
			
H28	H29	H30	H31
			
530 In 1	553 In 1	361 In 1	527 In 1
			
490 In 2	974 In 1	443 In 1	817 In 1
			
1027 In 1	355 In 2	355 In 1	598 In 1
			
1026 In	570 In 2		

Annex B-7. Colony morphology of 22 strains belonging to* C. musae *grown on PDA at 24°C for 10 days.

			
C3-1	C4-2	D48	D128
			
H28	H29	H30	H31
			
530 In 1	553 In 1	361 In 1	527 In 1
			
490 In 2	974 In 1	443 In 1	817 In 1
			
1027 In 1	355 In 2	355 In 1	598 In 1
			
1026 In	570 In 2		

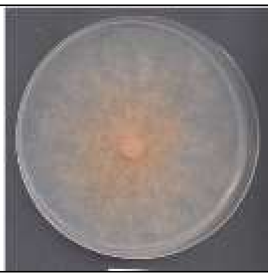
Annex B-8. Colony morphology of 22 strains belonging to* C. musae *grown on CLA at 24°C for 10 days.

			
C3-1	C4-2	D48	D128
			
H28	H29	H30	H31
			
530 In 1	553 In 1	361 In 1	527 In 1
			
490 In 2	974 In 1	443 In 1	817 In 1
			
1027 In 1	355 In 2	355 In 1	598 In 1
			
1026 In	570 In 2		

Annex B-9. Colony morphology of 22 strains belonging to* C. musae *grown on OMA at 24°C for 10 days.

			
C3-1	C4-2	D48	D128
			
H28	H29	H30	H31
			
530 In 1	553 In 1	361 In 1	527 In 1
			
490 In 2	974 In 1	443 In 1	817 In 1
			
1027 In 1	355 In 2	355 In 1	598 In 1
			
1026 In	570 In 2		

Annex B-10. Colony morphology of 22 strains belonging to* C. musae *grown on MRBA at 24°C for 10 days.

			
C3-1	C4-2	D48	D128
			
H28	H29	H30	H31
			
530 In 1	553 In 1	361 In 1	527 In 1
			
490 In 2	974 In 1	443 In 1	817 In 1
			
1027 In 1	355 In 2	355 In 1	598 In 1
			
1026 In	570 In 2		

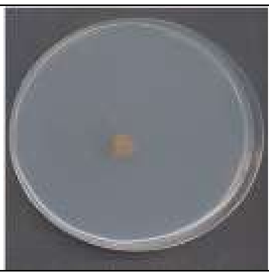
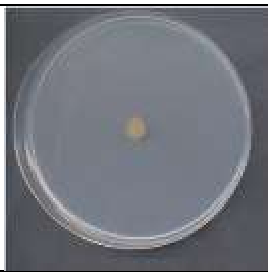
Annex B-11. Colony morphology of 22 strains belonging to* C. musae *grown on CYA at 24°C for 10 days.

			
C3-1	C4-2	D48	D128
			
H28	H29	H30	H31
			
530 In 1	553 In 1	361 In 1	527 In 1
			
490 In 2	974 In 1	443 In 1	817 In 1
			
1027 In 1	355 In 2	355 In 1	598 In 1
			
1026 In	570 In 2		

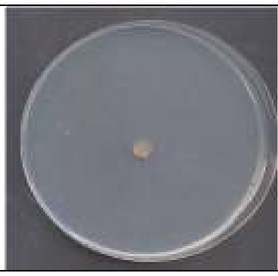
Annex B-12. Colony morphology of 22 strains belonging to* C. musae *grown on RV8 at 24°C for 10 days.

			
C3-1	C4-2	D48	D128
			
H28	H29	H30	H31
			
530 In 1	553 In 1	361 In 1	527 In 1
			
490 In 2	974 In 1	443 In 1	817 In 1
			
1027 In 1	355 In 2	355 In 1	598 In 1
			
1026 In	570 In 2		

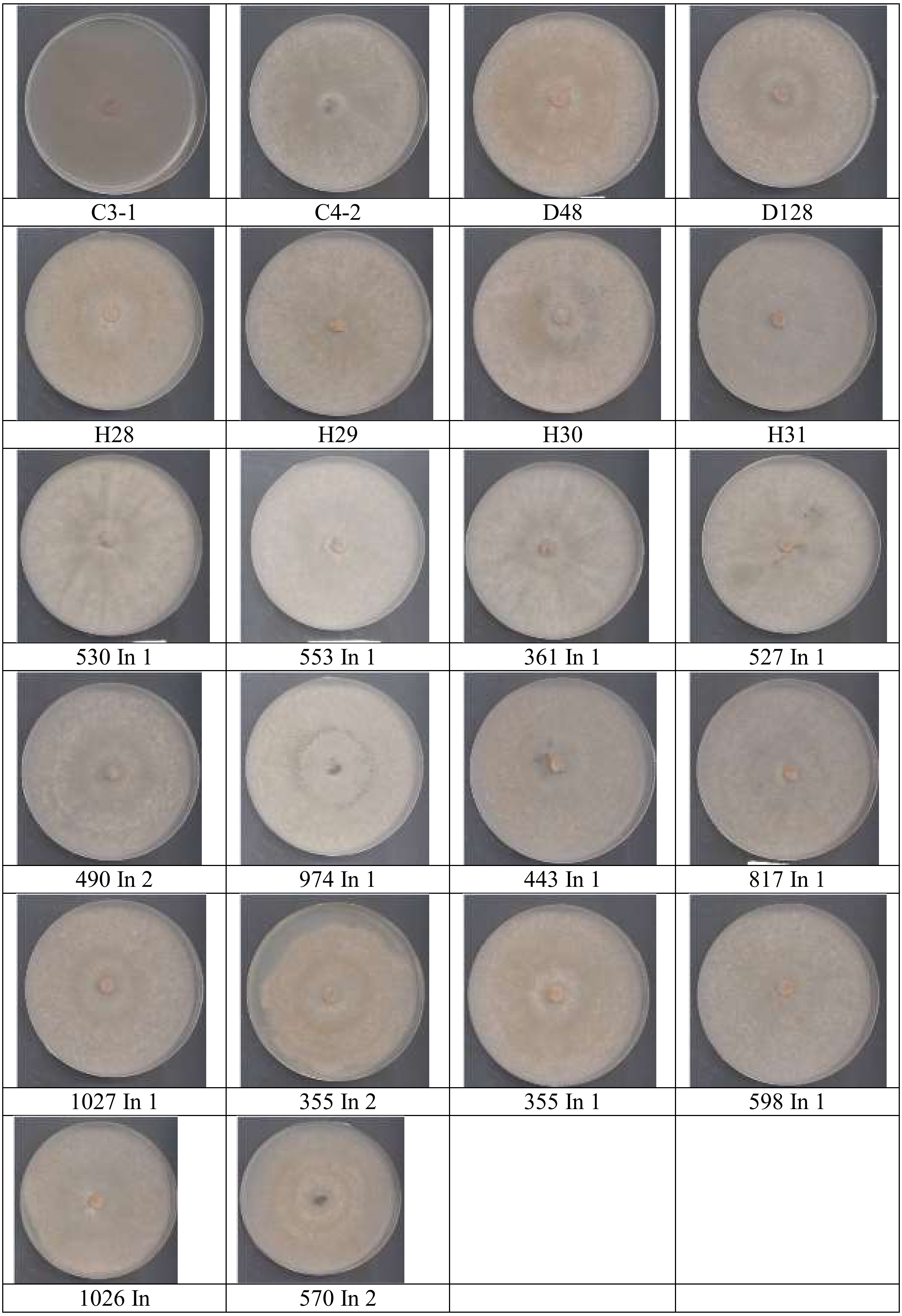
Annex B-13. Colony morphology of 22 strains belonging to* C. musae *grown on MEA at 24°C for 10 days.

			
C3-1	C4-2	D48	D128
			
H28	H29	H30	H31
			
530 In 1	553 In 1	361 In 1	527 In 1
			
490 In 2	974 In 1	443 In 1	817 In 1
			
1027 In 1	355 In 2	355 In 1	598 In 1
			
1026 In	570 In 2		

Annex B-14. Colony morphology of 22 strains belonging to* C. musae *grown on RA at 24°C for 10 days.

			
C3-1	C4-2	D48	D128
			
H28	H29	H30	H31
			
530 In 1	553 In 1	361 In 1	527 In 1
			
490 In 2	974 In 1	443 In 1	817 In 1
			
1027 In 1	355 In 2	355 In 1	598 In 1
			
1026 In	570 In 2		

Annex B-15. Colony morphology of 22 strains belonging to* C. musae *grown on WA at 24°C for 10 days.



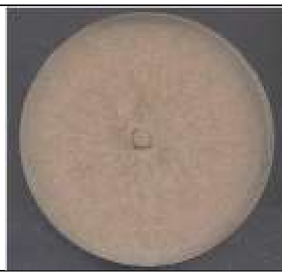
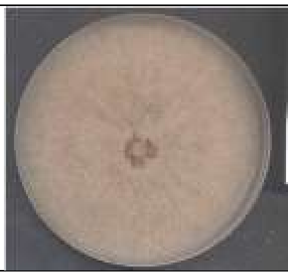
Annex B-16. Colony morphology of 22 strains belonging to* C. musae *grown on WGA at 24°C for 10 days.

			
C3-1	C4-2	D48	D128
			
H28	H29	H30	H31
			
530 In 1	553 In 1	361 In 1	527 In 1
			
490 In 2	974 In 1	443 In 1	817 In 1
I			
1027 In 1	355 In 2	355 In 1	598 In 1
			
1026 In	570 In 2		

Annex B-17. Colony morphology of 22 strains belonging to* C. musae *grown on PDA at pH 4.5 at 24°C for 10 days.

			
C3-1	C4-2	D48	D128
			
H28	H29	H30	H31
			
530 In 1	553 In 1	361 In 1	527 In 1
			
490 In 2	974 In 1	443 In 1	817 In 1
			
1027 In 1	355 In 2	355 In 1	598 In 1
			
1026 In	570 In 2		

Annex B-18. Colony morphology of 22 strains belonging to* C. musae *grown on PDA at pH 5.5 at 24°C for 10 days.

			
C3-1	C4-2	D48	D128
			
H28	H29	H30	H31
			
530 In 1	553 In 1	361 In 1	527 In 1
			
490 In 2	974 In 1	443 In 1	817 In 1
			
1027 In 1	355 In 2	355 In 1	598 In 1
			
1026 In	570 In 2		

Annex B-19. Colony morphology of 22 strains belonging to C. musae grown on PDA at pH 6.5 at 24°C for 10 days.

			
C3-1	C4-2	D48	D128
			
H28	H29	H30	H31
			
530 In 1	553 In 1	361 In 1	527 In 1
			
490 In 2	974 In 1	443 In 1	817 In 1
			
1027 In 1	355 In 2	355 In 1	598 In 1
			
1026 In	570 In 2		

Annex B-20. Colony morphology of 22 strains belonging to* C. musae *grown on PDA at pH 7.5 at 24°C for 10 days.

			
C3-1	C4-2	D48	D128
			
H28	H29	H30	H31
			
530 In 1	553 In 1	361 In 1	527 In 1
			
490 In 2	974 In 1	443 In 1	817 In 1
			
1027 In 1	355 In 2	355 In 1	598 In 1
			
1026 In	570 In 2		

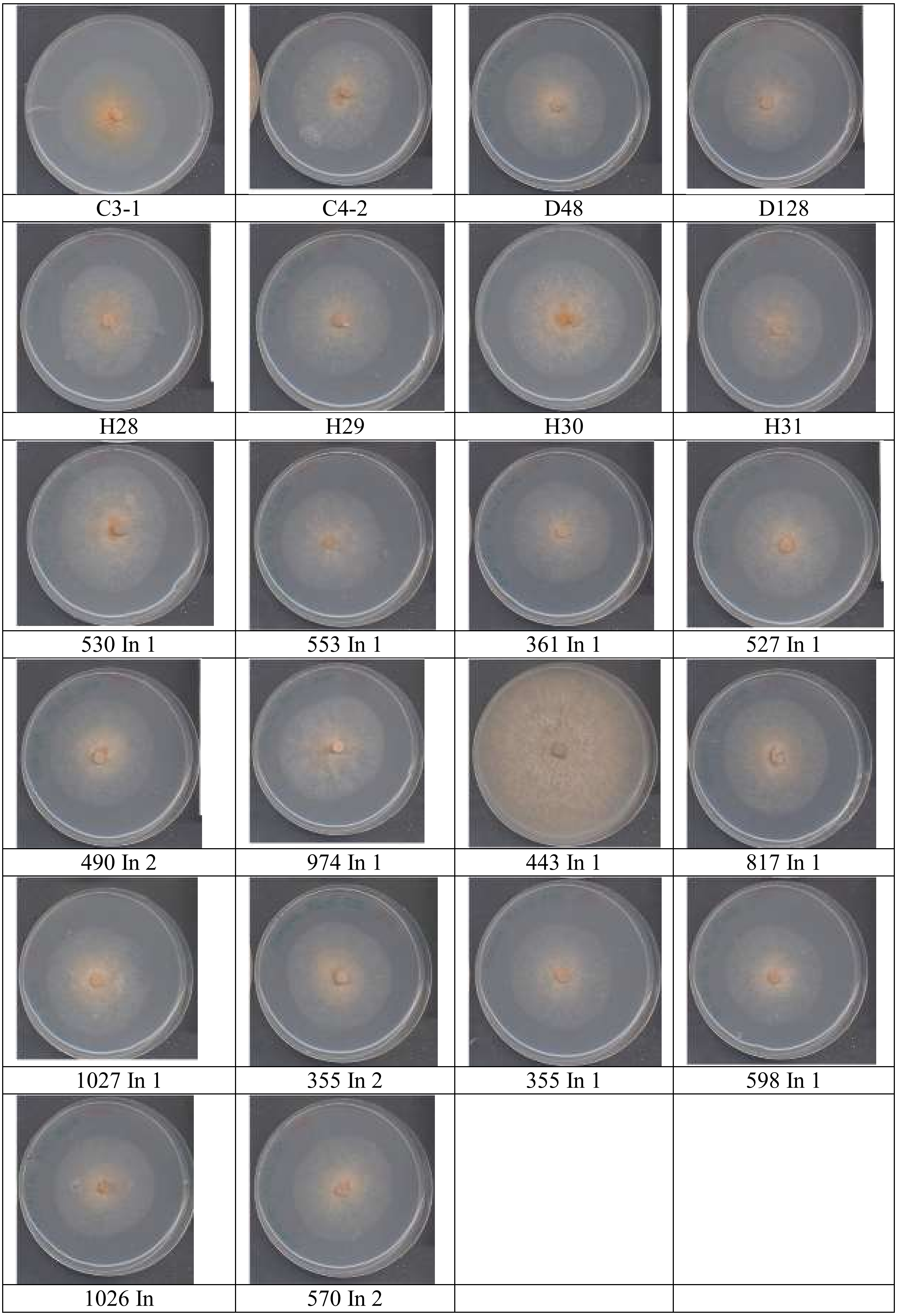
Annex B-21. Colony morphology of 22 strains belonging to* C. musae *grown on PDA at pH 8.5 at 24°C for 10 days.

			
C3-1	C4-2	D48	D128
			
H28	H29	H30	H31
			
530 In 1	553 In 1	361 In 1	527 In 1
			
490 In 2	974 In 1	443 In 1	817 In 1
			
1027 In 1	355 In 2	355 In 1	598 In 1
			
1026 In	570 In 2		

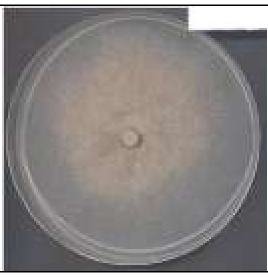
Annex B-22. Colony morphology of 22 strains belonging to* C. musae *grown on PDA at 5°C for 10 days.

			
C3-1	C4-2	D48	D128
			
H28	H29	H30	H31
			
530 In 1	553 In 1	361 In 1	527 In 1
			
490 In 2	974 In 1	443 In 1	817 In 1
			
1027 In 1	355 In 2	355 In 1	598 In 1
			
1026 In	570 In 2		

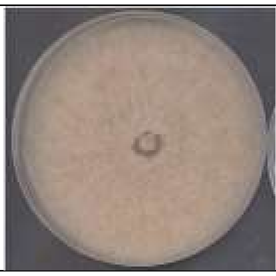
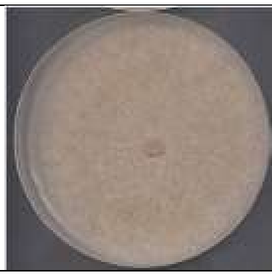
Annex B-23. Colony morphology of 22 strains belonging to* C. musae *grown on PDA at 10°C for 10 days.



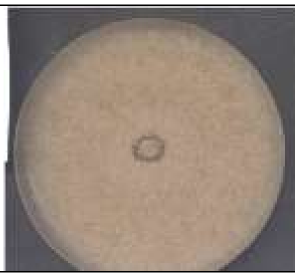
Annex B-24. Colony morphology of 22 strains belonging to* C. musae *grown on PDA at 15°C for 10 days.

			
C3-1	C4-2	D48	D128
			
H28	H29	H30	H31
			
530 In 1	553 In 1	361 In 1	527 In 1
			
490 In 2	974 In 1	443 In 1	817 In 1
			
1027 In 1	355 In 2	355 In 1	598 In 1
			
1026 In	570 In 2		

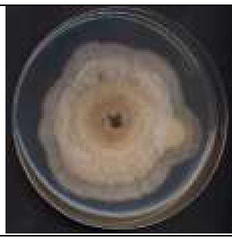
Annex B-25. Colony morphology of 22 strains belonging to* C. musae *grown on PDA at 20°C for 10 days.

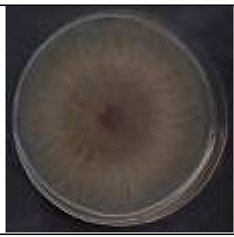
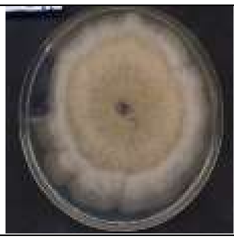
			
C3-1	C4-2	D48	D128
			
H28	H29	H30	H31
			
530 In 1	553 In 1	361 In 1	527 In 1
			
490 In 2	974 In 1	443 In 1	817 In 1
			
1027 In 1	355 In 2	355 In 1	598 In 1
1026 In	570 In 2		

Annex B-26. Colony morphology of 22 strains belonging to* C. musae *grown on PDA at 25°C for 10 days.

			
C3-1	C4-2	D48	D128
			
H28	H29	H30	H31
			
530 In 1	553 In 1	361 In 1	527 In 1
			
490 In 2	974 In 1	443 In 1	817 In 1
			
1027 In 1	355 In 2	355 In 1	598 In 1
			
1026 In	570 In 2		

Annex B-27. Colony morphology of 22 strains belonging to* C. musae *grown on PDA at 30°C for 10 days.

			
M A15	M A16	M B5	M B11
			
M B12	M C1-2	M C2-2	M C2-4
			
M C4-3	M C5-2	M D20	M D23
			
M D41	M D46	M D51	M D53
			
M D58	M D60	M D125	M D127
			
M D143	M D152	M D164	M D166
			
M D175	M D176	M D181	M D192

			
M D196	M D198	M D220	M D225
			
M D227	M E1	M E3	M E4
			
M F17	M F19	M F20	M F21
			
M F25	M F27	M F30	M F31
			
M F33	M H4	M H5	M I21
			
M I22	M I24	M I28	

Annex B-28. Colony morphology representative strains belonging to genus* Fusarium *grown on PDA at 24°C for 7 days.